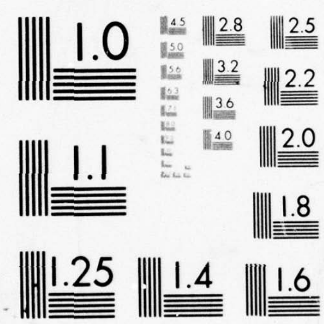
AD-A045 010 ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT--ETC F/G 5/2
SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS,(U)
1977 P I BERMAN
UNCLASSIFIED AGARD-AG-229 NL

1 OF 1
AD
A045010

END
DATE
FILMED
10-77
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A045010

(1)

B.S.

AGARD-AG-229

AGARD

ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

7 RUE ANCELLE 92200 NEUILLY SUR SEINE FRANCE

AGARDograph No. 229

Survey of Computer-assisted Writing and Editing Systems

by

P.I.Berman

NORTH ATLANTIC TREATY ORGANIZATION

DISTRIBUTION AND AVAILABILITY ON BACK COVER

(14) AGARD-AG-229

NORTH ATLANTIC TREATY ORGANIZATION

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT

(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

(11) 1977 (12) 67 p.

AGARDograph No. 229

(6) SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS,

by

(10) P. I. Berman
Lockheed Electronics Company, Inc.
A Subsidiary of Lockheed Aircraft Corporation
Plainfield, New Jersey, USA

400 043

This AGARDograph was prepared at the request of the Technical Information Panel of AGARD

THE MISSION OF AGARD

The mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace for the following purposes:

- Exchanging of scientific and technical information;
- Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;
- Improving the co-operation among member nations in aerospace research and development;
- Providing scientific and technical advice and assistance to the North Atlantic Military Committee in the field of aerospace research and development;
- Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;
- Providing assistance to member nations for the purpose of increasing their scientific and technical potential;
- Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community.

The highest authority within AGARD is the National Delegates Board consisting of officially appointed senior representatives from each member nation. The mission of AGARD is carried out through the Panels which are composed of experts appointed by the National Delegates, the Consultant and Exchange Program and the Aerospace Applications Studies Program. The results of AGARD work are reported to the member nations and the NATO Authorities through the AGARD series of publications of which this is one.

Participation in AGARD activities is by invitation only and is normally limited to citizens of the NATO nations.

The content of this publication has been reproduced
directly from material supplied by AGARD or the author.

Published July 1977

ISBN 92-835-1251-0

Printed by Technical Editing and Reproduction Ltd
Harford House, 7–9 Charlotte St, London, W1P 1HD

CONTENTS

ILLUSTRATIONS

SUMMARY

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends in automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

1. *INTRODUCTION: NEW TECHNOLOGY AND THE TECHNICAL AUTHOR*

Since 1964, more and more computer aids to text processing have become available, ranging from stand-alone, office-type *word processing* devices to large-scale, multiterminal, computer-based systems. Such systems encompass all phases of the text handling cycle, from text entry, editing, revision, and updating through composition and printout. The purpose of this study is to examine the impact of such systems on the technical writer and editor in the aerospace industry.

Commercial development of word and text processing systems has generally evolved from two sources: the office products industry and the printing and publishing industry. On one hand, the emphasis has been on partially automating the secretarial function -- eliminating repetitive typing, simplifying corrections, and improving the appearance of letters. On the other, the objectives have stressed quality, throughput, and cost -- that is, speeding up the process of preparing text matter for printing while maintaining or improving quality and lowering costs. Hence, there is one series of systems built around the secretary and another built around the publisher. In neither case is the primary concern for the author, particularly the technical author. Moreover, in both cases, the groups of technology were developed without much awareness of each other and, although parallel, even similar systems developed, there is very little compatibility among techniques. True, larger users have been able to combine these techniques to produce special-purpose technical publications systems designed to meet a specific requirement or group of requirements. But it would be difficult for a smaller technical group to use "off-the-shelf" components to build its own author-oriented system based on the type of input device, editorial capability, and output medium that seems best suited to its purpose.

These limitations are unfortunate, since the technical author -- researcher, design engineer, or technical writer -- is obviously a prime candidate for using computer-assisted text processing techniques. The technical author originates large numbers of documents (reports, specifications, manuals, parts lists, programming documentation, etc.) that are subject to frequent revision and updating. Yet the author is often not fully aware of the capabilities of computerized techniques as a helpful tool. On the contrary, these techniques are frequently regarded as an impedance the author must live with to automate the typing and production cycles. Since the technical author is seldom the one who specifies the equipment to be used, and it was not designed with him in mind, compromises are continually made -- often unfortunate ones -- to satisfy the limitations of the automated equipment.

To help the technical author in the aerospace field to become more familiar with the options open to him in automated publishing, the Technical Information Panel (TIP) of NATO's Advisory Group for Aerospace Research and Development (AGARD) sponsored this survey of computer-assisted word-processing and text-handling devices. The study considered both separate word processing techniques and integrated systems from the standpoint of the technical author.

During the course of this study, we visited many American manufacturers and received literature from scores of American and European manufacturers. We contacted dozens of users and specialists and attended or reviewed several meetings, including a workshop in Paris sponsored by AGARD TIP (see Appendixes). Based on this broad, but largely subjective and qualitative study, it seems that the technology available throughout the NATO community is roughly equivalent. Some of the more sophisticated techniques began in Europe, and organizations like Merganthaler, IBM, and Olivetti are truly international in scope. Where the United States seems to lead is, first, in sophisticated applications of technology and, second, in the more widespread use of automation in technical publications. But the differences may largely be a result of the greater magnitude of many of the publications tasks undertaken in the United States.

Section 2 of this report outlines some of the particular problems faced by technical authors in the aerospace industry. Despite the international character of this study, some of the specific problems of the NATO community are not covered, such as technical translation or the problems of optical character recognition (ocr) and computer typesetting in languages other than English, since these areas are outside of my field of knowledge and beyond the scope of this AGARDograph.

Section 3 of this report reviews current technology and tries to assess its impact on the future, as well as to set some criteria for using this technology. Section 4 demonstrates how this technology has been applied to solve some representative technical problems, and Section 5 sums up some of the conclusions of this report.

Finally, this report makes no attempt to recommend, criticize, or evaluate any of the techniques surveyed, or to favor any approach over any other. If it seems at times to ask more questions than it answers, that is in part intentional, since the purpose of this report is to help acquaint the technical author in the aerospace community with the challenges and pitfalls offered by automated publishing.

2. SPECIAL PROBLEMS OF THE AEROSPACE INDUSTRY

Before reviewing the current state of word and text processing technology, and then examining how such technology has been applied to aerospace problems, we should first examine some of the characteristics peculiar to the aerospace environment. Not that technical authors are *different*, or the problems that are briefly outlined here are exclusively in the province of science and engineering but, although most of the problems touched on are also found in other industries, taken as a whole, there is a certain user's profile that distinctly characterizes those who work with technical information in the fields of military electronics, aircraft, and space programs. These are some of the features that mark the aerospace industry:

1. *Large Quantities of Documentation.* - Research reports, technical proposals, design specifications, test procedures, computer programming documentation, technical manuals, parts catalogs -- all documenting highly complex systems -- make aerospace science and engineering almost a paperwork nightmare.

2. *Frequency of Changes.* - Technology is constantly changing; designs are continuously being upgraded and modified.

3. *Need for Extreme Accuracy.* - All technical material must be accurate; aerospace data, for obvious reasons, must be moreso. Yet, each time we introduce changes, we add the possibility of introducing errors. Each cycle of correcting errors presents another chance to introduce new ones.

4. *Use of Complex Terminology.* - Again, this is a problem common to all technological information. But the fact remains that specialized vocabularies make oral transmission techniques, such as dictating into a central recording system, difficult to use. Moreover, they introduce the probability of errors in handling by operators, typographers, draftsmen, illustrators, editors, and proofreaders.

5. *Need to Reproduce Mathematics.* - Mathematics compounds the problem of oral transmission and makes composition difficult by any means other than hot typesetting systems and the more sophisticated photocomposers. Typewriters, single-element printers, line printers, and so forth, have yet to satisfactorily handle complex mathematics.

6. *Need for Security.* - To the normal problems of industrial security we must add, for much aerospace work, the rigorous requirements of military security.

7. *Large-Scale Storage Requirements.* - Since much aerospace documentation is subject to change and reuse, and since aerospace programs commonly last ten or more years, going through many cycles of design maturation, it is not uncommon to have large quantities of technical data that must be stored, accessed, retrieved, and kept up-to-date for long periods of time.

8. *Need for a Variety of Outputs.* - Many aerospace documents -- program listings or parts catalogs, for example -- are commonly printed out on high-speed printers. For others, like proposals and reports, correspondence-quality typewriters or single-element printers are needed. For still others, such as training manuals, justified typeset quality is required. In some cases, microform outputs are needed. Sometimes data must be available in a form that can be fed to another computer -- punched cards, for example. And often, the same organization must be able to provide outputs in all of these formats.

9. *High Percentage of Graphics.* - The picture, the chart, the graph, the table, the photograph -- these are essential components of technical information. And the more advanced the technology, the more we rely on graphic communications. Unfortunately, although text processing has been relatively easy to automate, most graphics are still produced and reproduced by manual techniques.

Finally, as we view the advances in the technology of documentation, we must always keep in mind the practical limits of such technology. The system designed to speed up documentation may, if it is too complex for the application, actually slow it down. Some of the systems described in Section 4 are, according to its users, neither faster nor cheaper on a per-page basis than more conventional techniques. They simply seemed the most practical way to handle large volumes of information rapidly and efficiently. In other cases, the automated techniques were selected primarily because they produced superior accuracy, in that subsequent revisions did not introduce errors, since only changed material had to be revised and proofread.

In short, given current technology, as described in the subsequent sections, one could postulate a system in which a technical author creates material sitting at a visual display unit (vdu) connected to a central computer. There is no pencil or paper. The author types in material and reads it on the vdu screen, editing and rearranging it until satisfied. The terminal also has graphics capability, and drawings, charts, graphs, and equations can be created on the screen and then stored for future use. Before returning a draft copy in computer printout form, the computer checks the author's spelling and use of acronyms against a stored "dictionary." It may even analyze the readability level of the document, telling the author whether his material is easy or difficult to comprehend. When the author gets the draft copy back, he marks up the corrections and gives it to an editor, who "calls up" the document on the vdu, enters changes, corrections, and output codes, keys illustrations for proper insertion, and signals for the desired output format and medium. The output may be in the form of a microfiche card, or a roll of microfilm, or negatives of typeset material ready for printing. The computer automatically creates the table of contents, list of illustrations, and index after it has laid out and composed the entire document. When sections of the finished document are required for future use, the author calls them out of storage, scrolls through them on the vdu, makes changes as necessary, and creates a new document.

As the following sections show, such systems are entirely within the potential of present-day technology. What each user must decide is: How much technology is needed? How much can be afforded? How much is wanted? How much can the user and the user's organization absorb, and at how fast a pace, without totally disrupting traditional operating methods?

It is the purpose of this report to provide some qualitative guidelines and some suggestions and examples, that, hopefully, will help the technical author understand the possibilities of automated publishing systems and, perhaps, aid him in accommodating to change in as painless and positive a manner as possible.

3. BRIEF REVIEW OF CURRENT TECHNOLOGY

3.1 BACKGROUND OF AUTOMATED PUBLISHING

The terms *word processing* and *computer-assisted text editing* both came into the technical communications vocabulary during the past few years. The terms have been used rather loosely by some writers, although most consider computer-assisted text editing to be simply a particular word processing technique. Actually, the two terms come from different backgrounds with different orientations. Word processing as a term was first coined by IBM and associated with office systems -- with dictating equipment, typing pools, and power-typing equipment such as Auto-typist, Redactron, and MT/ST and Mag Card II. Word processing has now come to refer to total document-producing systems -- from initial creation to final publishing.

Computerized text editing came into being when large computer users realized they could use their machines to store, edit, revise, update, and print out routine administrative reports. IBM's Administrative Terminal System (ATS) was a pioneer in this area. From here it was a simple step to use these machines to revise and print out large repetitive documents that changed only slightly between revisions -- documents such as specifications, procedures, and technical manuals. Today, systems like the Navy's TRUMP (Technical Review and Update of Manuals and Publications), Lockheed's Autotext Publications System, and IBM's ATMS (Administrative Text Management System) are examples of large-scale computer power applied to publishing technical material.

A third area of development was that of high-speed phototypesetting equipment capable of being driven by computers or by computer products such as punched paper tapes or magnetic tapes. These devices, we know, have revolutionized the printing industry. When the outputs of word processing or computerized text-editing systems are coded to input to a phototypesetting machine, we have the basis of modern computerized publishing systems. On the smaller end of the scale, however, for many publications groups, a keyboard plus a storage medium plus editing capability plus an output device capable of creating typewriter quality repro, constitutes a publishing system. For this study, we are concerned with both types of systems and their impact on the technical author and editor, as well as on the aerospace industry.

Basically there are four elements to any computerized publishing system:

- Text entry and storage.
- Editing and revision.
- Composition.
- Final output.

Note that any one, two, three, or four of these elements can be performed within the author's own facilities or off-premises, although the first and second are generally grouped together, as are the third and fourth. These first two areas -- text entry, storage, editing, and revision -- constitute computer-assisted text editing. This process is also referred to frequently as *text processing*, to distinguish the automation of relatively large, complex documents from the office environment suggested by the term *word processing*.

3.2 TEXT PROCESSING OPTIONS

There are several ways to approach computerized text processing:

- Stand-alone systems.
- On-line dedicated systems.
- On-line remote time-shared systems.
- Off-line (batch-processed systems).

Stand-alone systems fall into several areas. On the lower end of the spectrum we have automatic typing systems such as Autotypist. In the middle are power-typing systems such as IBM's MT/ST or Mag Card II, Redactron, CPT, Xerox 800, and the Wang series; these systems are capable of many editorial functions. At the other extreme, we have stand-alone text-editing terminals such as those made by Lexitron, Vydec, Omnitext, and Linolex (see figure 3-1). These generally include a keyboard, vdu or cathode ray tube (crt) for editing and logic, and an output printer.

In *on-line systems*, we start with minicomputer shared-logic or shared-processor systems such as Astro-comp, DataText, Text-Ed, Wordstream III, and Compu-TEXT, which permit anywhere from one to several terminals to feed directly into a small computer (see figure 3-2). The input devices to these *cluster* systems can be Selectric typewriter terminals or vdu editing terminals, or a mix; output can be a typewriter or a higher-speed character printer such as the Qume or Diablo, which operate using a *daisy wheel* element, or still higher-speed line printers. At the other end of the scale are larger

computers handling many terminals. In these systems, input devices are often a mix of typewriters and vdu terminals; the typewriters are used primarily for data entry and the vdu's for editing and revision. Output devices may include high speed line printers and phototypesetting options (see figure 3-3).

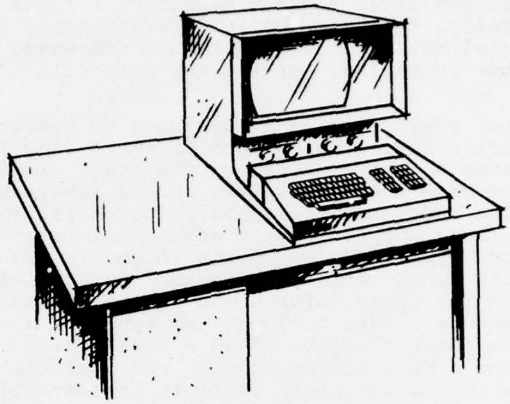


Figure 3-1. Stand-alone Text Editing Visual Display Unit (Vdu)

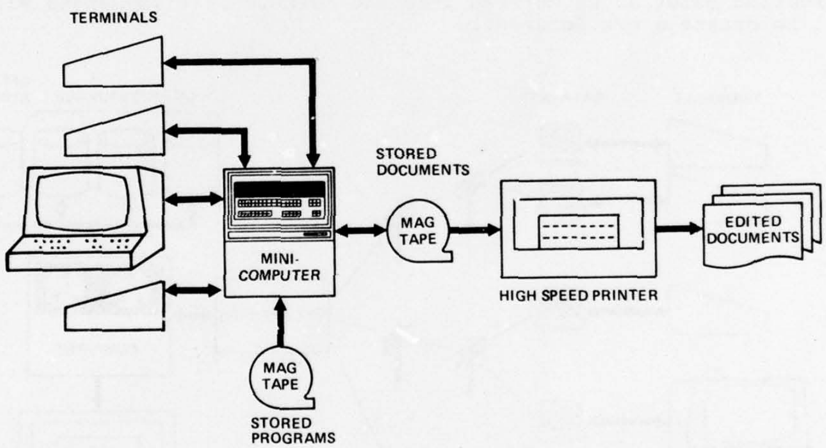
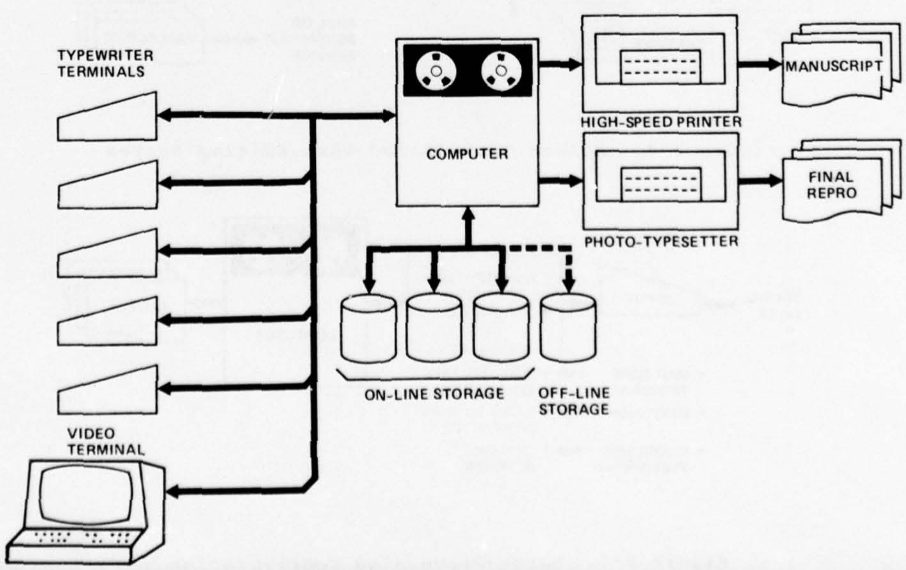


Figure 3-2. Minicomputer Shared-Logic Editing System



Remote time-shared systems, such as Word/One operated by Bowne Time Sharing in New York and PCS/Text of Proprietary Computer Systems (PCS) in California, are an attempt to bring big computer power to smaller users (see figure 3-4). The various remote users type at terminals connected via telephone line to a remote central computer. The computer stores the documents, and the user can *address* a document and modify it by referring to its storage address via the terminal. A single-element typewriter terminal can be used for printout or, for large documents, either a local or remote high-speed printer can be used. Generally, the time-sharing service sends the user a line-numbered printed output of the material entered. The user then addresses the material by stored record number and line number to revise, correct, or update it.

Still another option -- *batch processing* -- is designed to overcome some of the shortcomings of the other approaches for certain types of users (see figure 3-5). Stand-alone and minicomputer systems do not always have the power and flexibility that some larger users require. These same users, however, do not always have the consistent volume to justify a dedicated large-scale computer. Moreover, in time sharing, the user is tying up a portion of a large computer while entering data at the relatively slow rate at which an operator can type. If the user's volume is big enough, this can become an expensive operation. With batch-processing systems -- such as Volt Information Science's Voltext/Voltype -- the typed information may be stored on some intermediate medium, such as magnetic tape or cards, or it may be typed in a machine-readable typeface and entered into the computer by means of an optical character recognition (ocr) device. Periodically -- once a day, for example -- the operator's recorded output is forwarded by messenger to a remote computer; there it is converted into computer-acceptable format and entered into the computer along with the outputs of other users. A high-speed printer prints out a line-numbered copy for use as rough draft. For editing and corrections, instead of addressing the computer directly as in the previous methods, the user types a coded series of corrections, keyed to the original, on the same medium. When the correction material is entered into the computer, it is merged with the original material to create a new document.

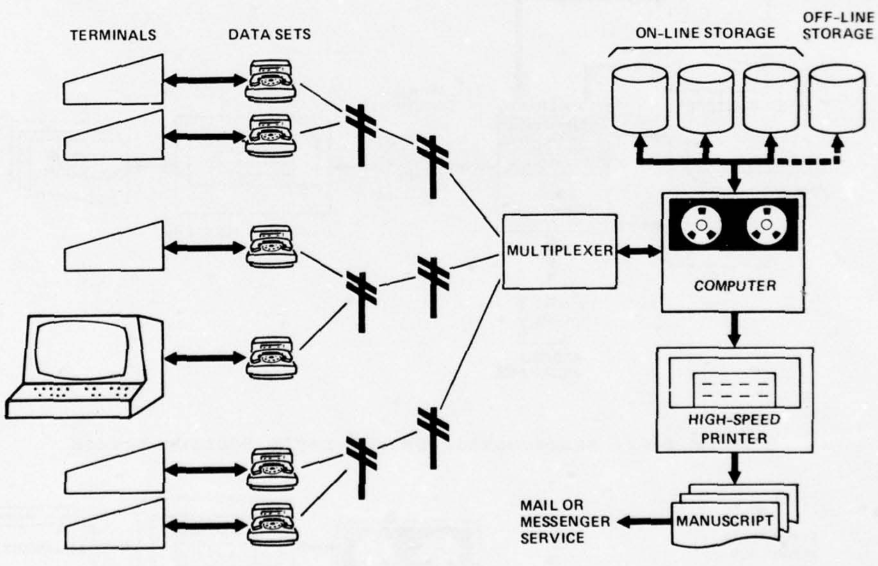


Figure 3-4. Remote Time-Shared Text Editing System

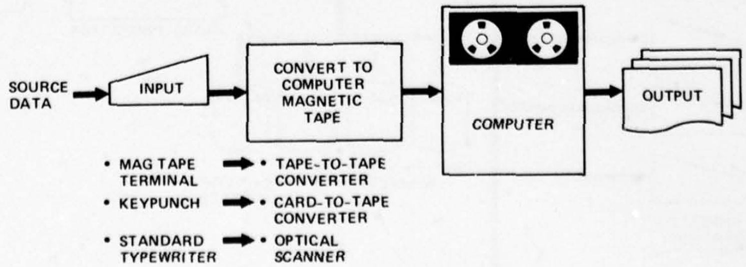


Figure 3-5. Batch-Processing Configuration

3.3 RECENT TECHNOLOGICAL ADVANCES

The period from 1964 to 1974 was the era of developing technology in the word and text processing fields. We saw the period begin with the emergence of two kinds of systems: the big computer-based systems geared to large-scale production of huge amounts of documentation, and the stand-alone automated typing terminals, such as MT/ST, designed to simplify routine office functions. In the latter half of this ten-year period, as minicomputers proliferated, the *cluster* or *shared-logic* systems came into being. These systems tried to add more real publications power to the stand-alone system without becoming prohibitively expensive for the medium-sized user. As a sort of parallel development, the batch-processed and remote time-shared systems attempted to bring big computer power to the small user. The basic input to most systems -- stand-alone, shared-logic, large-scale computer, batch processed, or time shared -- was the IBM Selectric typewriter. As a single-element typewriter, it had no keys to jam, it could print out at about 150 to 180 words per minute, and it made an excellent device for translating mechanical signals to sound pulses to electronic signals. Vdu terminals were becoming available during this period as an editing option for more sophisticated systems.

Now, what has happened since then? Well, first some new technology, and some improvements on the old:

- The microprocessor has brought true minicomputer power to very small systems. Stand-alone systems have thus been given increased performance at reduced cost.
- Vdu's have come down in price, and they are now available in office-type stand-alone systems.
- New single-element character printers, such as the Qume or Diablo, based on the *daisy* or *pin-wheel* principle, are offering correspondence quality at speeds of 350 to 600 words per minute. An even newer approach being introduced by Qume -- a double-element printer -- will double the available character set and offer such possibilities as mixing typefaces or producing relatively complex mathematics in an office environment. Called TwinTrack, the two-headed printer offers two daisies, each with its own character set, operating independently.
- Phototypesetting units keep getting cheaper and smaller, so much so that many aerospace firms are electing to become almost complete publishing houses.
- Floppy-disk (or diskette) storage provides greater storage capacity and random access features in small systems, overcoming many of the limitations of earlier magnetic tape and card systems.
- Ocr offers a unique way of getting text into computers for editing and composition without capturing it first on some intermediate medium, such as magnetic cards or tape or punched paper tape.
- Large computer-based publishing systems are now capable of scanning and storing illustrations, creating illustrations, and even merging pictures and text.
- Computer-output microfilm (com) provides a means of going directly from computer-stored data to a microform output.

But what has all this to do with the technical author and editor? Unfortunately, not enough. As we stated before, most of the new technology has come from other industries -- newspapers and publishing, office products, administrative management, and so forth. Very few of the manufacturers of such systems seem very aware of the problems of successive revisions of technical manuscripts; the need for outputs in specified formats and typefaces; the need to be able to handle superscripts, subscripts, equations, symbols, complex tables; the requirement to be able to maintain military security; and so on. Most of the manufacturers seem to have aimed their sales efforts toward modernizing the typing pool, or automating a newspaper or magazine. Others have designed features particularly to appeal to the banking or legal or insurance communities. In fact, not only do the varying segments of the word processing industry have little knowledge of aerospace problems -- they do not even seem very aware of each other (at least, not until fairly recently). In short, the technical author or editor is faced with a proliferation of devices and systems whose designs were primarily intended for other uses. Very large users, of course, can use these devices as "building blocks" with which to create their own systems. The smaller user does not yet have this option. The time has come, however, for the technical author to educate himself in these new technologies, because their impact is going to be very substantial in the next few years.

First, there is growing evidence that the manufacturers in the field are becoming increasingly aware of the need for more versatility within their systems and more compatibility among systems and devices. More and more word processing terminal manufacturers, for example, are stressing compatibility with phototypesetting devices, with ocr input machines, with large-scale computers via various telecommunications media, and so forth. In short, the user is now able to have a stand-alone terminal and use it to input to a large-scale computer via telephone line or ocr, or have it produce outputs to a photocomposer via some tape-conversion medium, or have it create a data base for a com system, or use it as a stand-alone editing and production system for smaller jobs.

Other manufacturers have expanded their product lines to extend them into varying markets. Wang's System 30, for example, is a minicomputer-based system that allows a variety of inputs and outputs. And IBM's System 6 allows Mag Card typewriters to input into a central processor with a vdu editor to give a combination of stand-alone terminals that can feed a cluster system. The jet spray printer that accompanies System 6 adds a new level of speed and quality to office printers.

Second, new technology is proliferating so rapidly that stand-alone terminals for smaller users, and cluster systems for medium-sized users (say, six or more terminals), will routinely offer such features as:

- Major editing and revision routines.
- Floppy-disk storage for true random access.
- Vdu's for ease of editing.
- High-speed character printers or jet spray printers offering proportional spacing and correspondence quality, with a wide variety of typefaces and symbology, and the ability to handle subscripts and superscripts.

Third, the military is increasing its requirements for automating data, as exemplified by the U.S. Navy's proposed Navy Technical Manual System (NTMS) and the Air Force's contemplated Automated Technical Order System (ATOS). The United States defense establishment wants to be able to purchase a data base as well as hard copy and negatives, and update and republish manuals rapidly by using computer techniques. They also want to be able to produce hard copy or microform from the same data base. Their needs should force more of us involved in technical publications to seek ways to automate our facilities. At the same time, the fact that the services are beginning to approach publications on a system-wide basis should encourage more compatibility among devices and techniques.

In short, any text processing medium that a future defense contractor or aerospace manufacturer selects will probably have to be capable of providing revision, updating, and publication of the many successive editions of a manual that are produced while the contractor is still responsible for the production and support of a system. But the system will also have to store the data in some form that is suitable for delivery to the customer and compatible with the customer's future revision and updating systems.

3.4 CRITERIA FOR SYSTEM SELECTION

The devices we have been examining are, as previously stated, primarily building blocks for technical publications. And, for the most part, they are *front-end* modules -- the text entry, storage, and revision devices, since these are the aspects of word and text processing of most concern to the technical author. It should be kept in mind, however, that many of these devices are in themselves complete publications systems in that they accept the data, process it, and print it out in the final format in which it will be used. In Section 4 of this report, we will look at some specific system configurations. Before we do, however, it will be useful to look at some of the criteria upon which system choices are based.

Figure 3-6 shows, conceptually, some of the factors to be considered in publications system design. Since we show it as a closed-loop system, we could theoretically begin anywhere in listing our system design criteria. But as in other forms of system design, it is useful to begin with the user and work backwards.

Information User

- What does the user need? What does the user have available? Is the user a scientist reading a technical report? An airline technician with a microfilm reader? A researcher with a vdu accessing a data base?
- How current must the user's information be?
- Where is the data used? In cramped quarters aboard a submarine? In a research library? At home?
- How is the data used? How is the user used to seeing it?

Output Subsystem

- What form do we want? Hard copy? Microform? Film? Visual display?
- What quality do we need?
- What format requirements are imposed?
- How do we handle graphics? Are halftone illustrations required, or only line drawings? Must pictures and text be merged? Do we have to handle large drawings?
- What output speed is required?
- What volume will be handled?

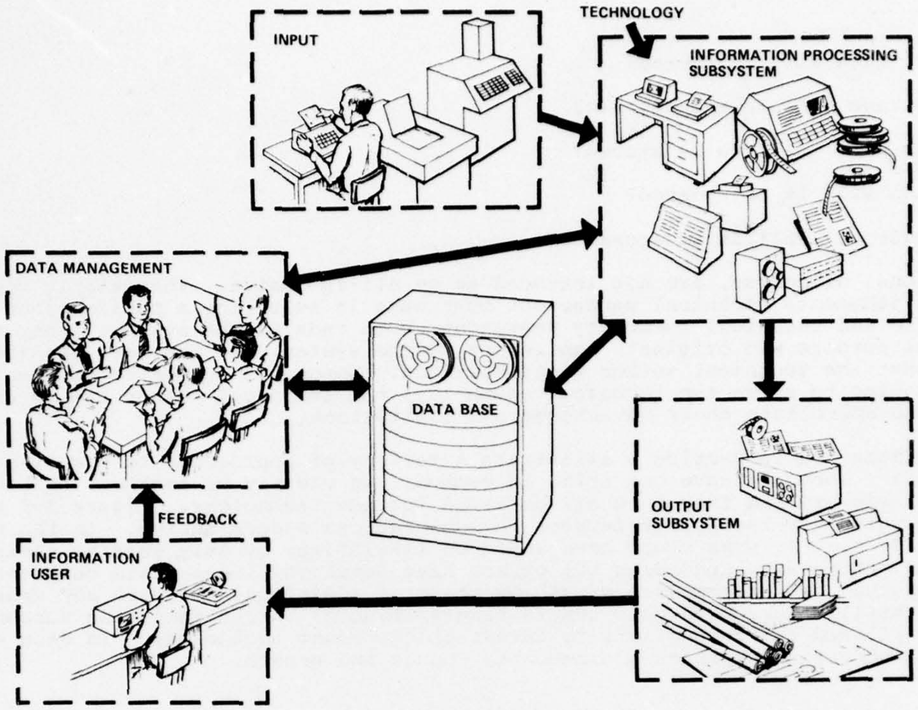


Figure 3-6. Publications System Design

Information Processing System

- How is data updated? How often?
- How much editorial capability is desired? Required?
- Must mathematics be handled? Complex tabular material?
- What volume of material will be handled? What percentage is updated?
- Must we communicate between terminals? With a computer? With other systems? With remote locations?
- Is the information processing subsystem also the output system?

Input

- How much input material is handled? How often?
- Is the input load steady or fluctuating?
- Does the technical author input the material? An editor? A typist or word processing operator?
- What is the ratio of inputted material to updated material?
- What skills must the inputter have?

ata Management

- How do we make sure that data is captured, kept up-to-date, stored, identified, published, and distributed in a timely, economical, and efficient manner?
- How do we allocate and control costs?
- How do we access and retrieve material?
- How do we measure system effectiveness?

Data Base

- How much data will be stored?
- What storage media are available?
- How long will the data be stored?
- How often will it be updated?
- How frequently will it be accessed?

These questions, of course, are not intended to be all-inclusive. They simply represent the kinds of judgments technical management must make in selecting a publications system. The scientific and technical community represents both ends of the system: they are the technical authors who originate the inputs to the system, and they are the information users that the technical author wants to reach. Hence, if automated publishing systems are going to serve the technical community, the technical author has to understand them and appreciate their advantages and limitations.

The systems described in Section 4 illustrate a variety of approaches to managing technical data. They all have one thing in common: in one way or another, they have all been evolutionary and they have all provided for new technology. Figure 3-7 suggests the areas in which new technology impacts on publications system design. In the systems described in Section 4, some users have achieved flexibility by only leasing their equipment and continually upgrading it; others have developed large-scale computer-based systems that can accommodate growth by means of additional software and upgraded peripherals; still others have used remote time-sharing or batch-processing subcontractors who allowed their suppliers to invest in the newer technology. In each case, however, the successful approach accommodates change and growth.

Finally, all systems do not have to be based on the latest in complexity and sophistication. Not every user can afford it, and not every user has the volume to justify it. Many of the users -- even large users -- described in Section 4 have opted for relatively simple approaches. Figure 3-8 is a cost comparison of systems on the lower end of the scale: stand-alone work stations, stand-alone vdu work stations, and mini-computer-based shared-logic systems. Again, there are no hard and fast rules. Some stand-alone vdu's, for example, permit an auxiliary terminal to operate off the master terminal's logic. Moreover, there is a wide variety of editing capability and output speed and quality available among the various systems. Some can input to a photo-composer; some offer telecommunications capability; some have auxiliary business computational functions; and so forth. The chart (which is admittedly crude, and whose figures are changing almost daily) does make some general points:

There is a system in every price range. Start with what you need. Despite the proliferation of vdu's, there are many manufacturers, including IBM, A.B. Dick, CPT, and Xerox, who seem to believe that a large segment of the market does not need that much sophistication.

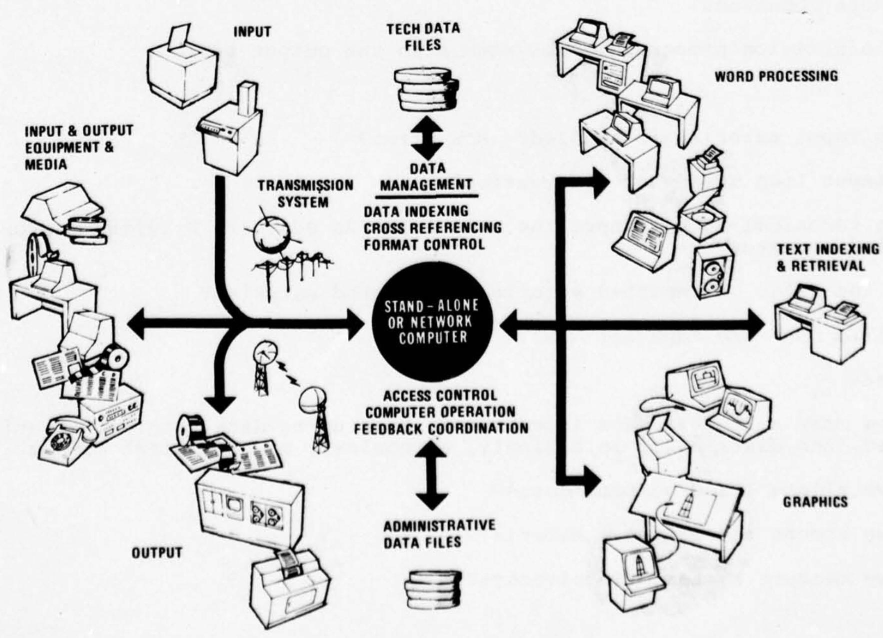


Figure 3-7. Flexibility for New Technology

- If relatively simple editing and output routines are all you require, you may never want to go beyond the stage of adding more stand-alone work stations as you need them.

- If you need more sophisticated systems, and you want more than three or four terminals, you should also investigate shared-logic approaches or some other means of accessing a more powerful device.

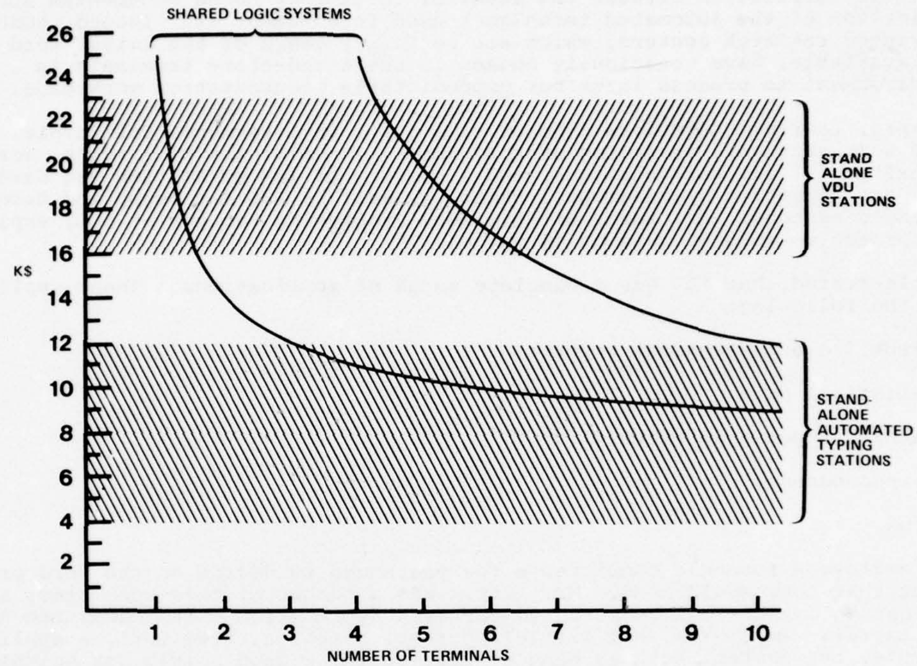


Figure 3-8. Cost Comparison of Various System Types

4. BASIC SYSTEM APPROACHES

4.1 DECENTRALIZED STAND-ALONE WORK STATIONS

Although we tend to assume that technology begets technology, and that, therefore, those aerospace organizations that are doing the most sophisticated research would be drawn toward the most sophisticated word and text processing techniques, there actually seems to be little correlation between the level of technology being documented and the sophistication of the automated techniques used to document it. Indeed, some of the most advanced research centers, which are certainly aware of the latest word processing systems available, have consciously chosen to use stand-alone terminals in a decentralized environment to process large but unpredictable documentation workloads.

For example, Lawrence Livermore Laboratories (LLL) in Livermore, California, has more than 100 work stations, including over 30 Wang 1222 terminals with vdu's, more than a dozen Lexitron 92 vdu work stations, and a variety of IBM MT/ST, IBM Mag Card, Vydec, Linolex, and Redactron stand-alone systems, as well as ICS Astrocomp and Daconics shared-logic systems. Mr. Larry Little, Word Processing Manager at LLL, explained that their approach to word processing is unique.

Mr. Little stated that LLL has a complete range of applications. These applications include the following:

- Scientific and technical reports.
- Statistical data.
- Standard repetitive material.
- Correspondence.
- Forms.

Six LLL employees formed a committee a few years ago to decide on the word processing equipment that they would need. Mr. Little was a member of this committee, and he stated that an example was constructed for each application. The committee decided to install *magnetic keyboards* (Mr. Little's phrase) based on these various applications. For example, one system, such as Wang's 1222, would be used solely for scientific and technical reports, while a different system, such as IBM's Mag Card II, would be used for correspondence. The Wang system would be used for reports because reports tend to be long, undergo heavy revisions, and have many superscripts, subscripts, and Greek symbols. But correspondence tends to be short with light revisions; thus, the Mag Card II would be sufficient. Mr. Little stated that the forms application has been difficult to solve because word processing systems are still inflexible in this area.

Mr. Little, as the Word Processing Manager at LLL, reviews and approves all equipment acquisitions. He is informed by a department of inadequate word processing and, after a thorough investigation of the department's needs, Mr. Little decides whether or not to authorize the acquisition of additional equipment.

LLL's scientists in widely dispersed laboratories interface with the various word processing machines via approximately 40 technical editors who revise the various draft reports and arrange for their publication. LLL makes no attempt to justify its approach as cost-effective (except as compared to manual typing), but as a practical way to support the varying requirements of a very diverse, highly decentralized research organization.

John P. Carrier, Scientific and Technical Information Officer at the U.S. Army's Harry Diamond Laboratories (HDL), also prefers the flexibility of a decentralized system built on stand-alone work stations (they are currently using Wang 1222 systems). He states, in describing HDL's approach (1):

> As needs change and new branches are added or reduced, word processing operations can be adjusted with minimal effort. Should future needs demand a more centralized word processing effort, contraction of these branch-oriented modules would not be difficult. Redistribution of equipment and trained personnel would be relatively simple. The mechanism exists to continue training throughout the system, and, once familiar with the tape-to-tape concept using the Wang, operators are current with the state-of-the-art. As more sophisticated equipment becomes available, word processors are well prepared to advance to the next generation of machines. Here I would like to make one budgetary comment. Flexibility requires renting as opposed to buying word processing equipment. Renting allows an organization to remain open to changes in the number of machines it uses and their organization. Not only can reorganizations and redistributions of equipment be accommodated more easily with rented machines, but a changeover to a more advanced system is more feasible economically.

Typical workflow for HDL's approach is shown in figures 4-1 and 4-2. Interestingly, both LLL and HDL seem opposed to two general tendencies in the word and text processing environments: one is the office-oriented theory that stand-alone machines be grouped together in *word processing centers* -- the descendants of what used to be called *typing pools*; the other is the feeling that many large technological users have that multiple stand-alone systems should be replaced by shared-logic systems.

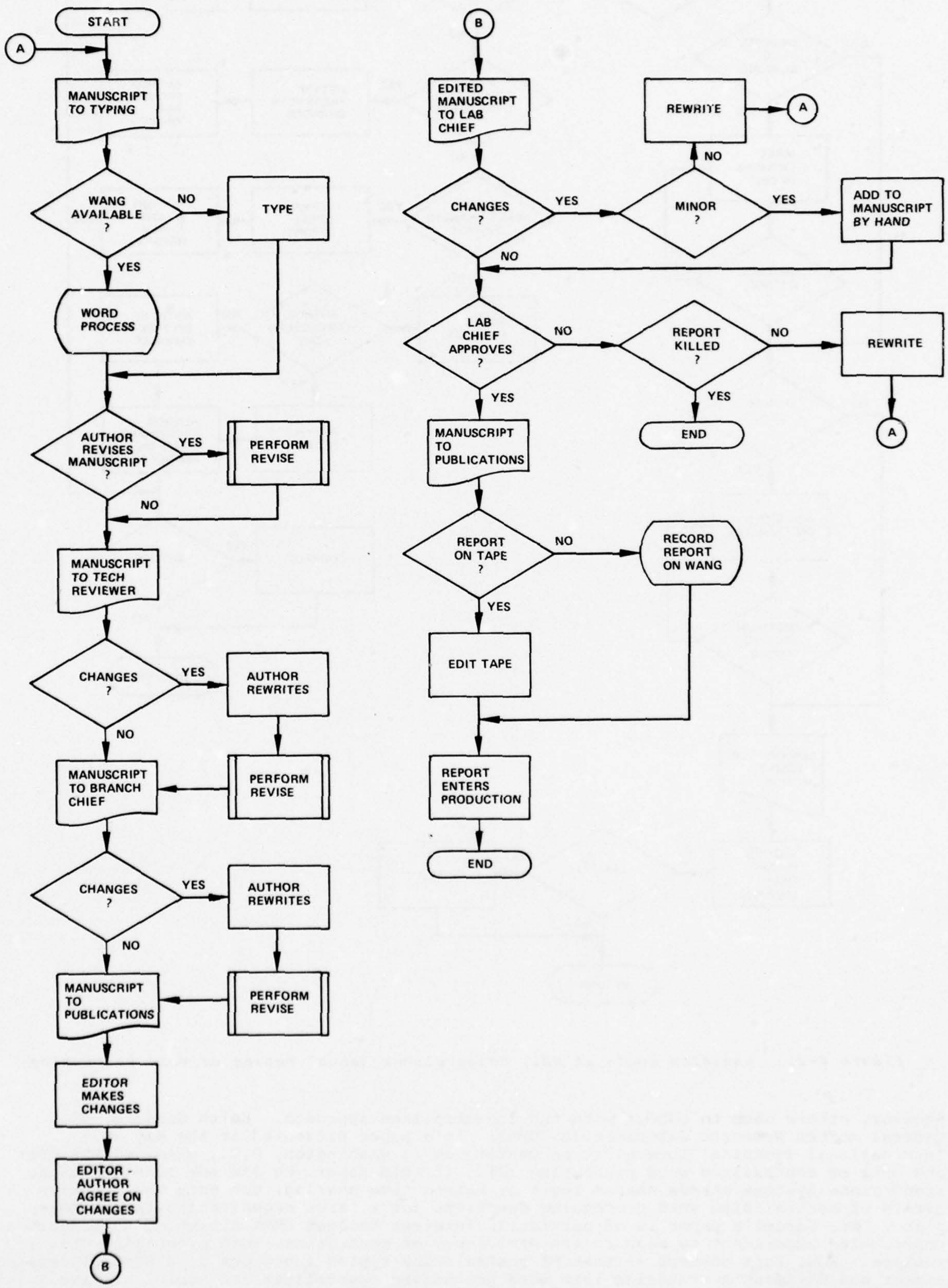


Figure 4-1. Basic Text Entry at HDL, Using Either Manual Typing or Word Processing

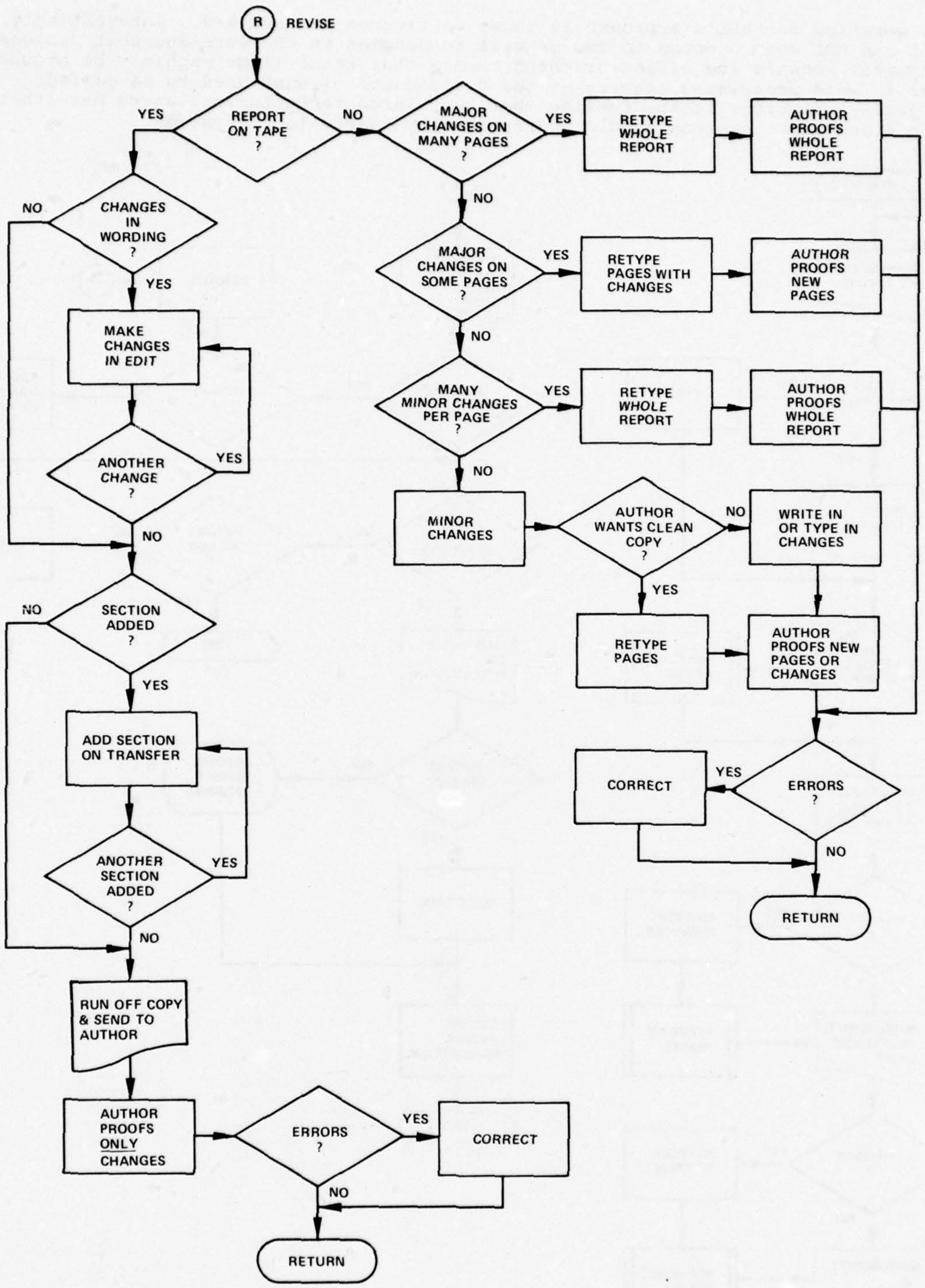


Figure 4-2. Revision Cycle at HDL, Using Either Manual Typing or Word Processing

However, others seem to concur with the decentralized approach. Keith Gardels, of General Motors Research Laboratories (GMRL), in a paper presented at the May 1976 International Technical Communication Conference in Washington, D.C., examined the pros and cons of centralized word processing (2). In this paper, he did not consider using stand-alone systems versus shared logic or remote time sharing, but only the relative merits of centralizing word processing functions for a large organization in a single place. Mr. Gardel's paper is of particular interest because GMRL attempted to conduct a constructed experiment to measure the efficiency of centralized word processing organizations. Now, this concept -- that of centralizing typing functions in a word processing center and dividing secretaries into word processing specialists and administrative secretaries -- has been highly touted by various equipment manufacturers and word

processing consultants as providing efficiency, productivity, cost savings, and job enrichment. On the contrary, GMRL found no statistical evidence that a centralized approach is any more efficient or productive, and considerable evidence that a decentralized cluster arrangement was "more job enriching, less monotonous, and an equally productive arrangement."

In this regard, Gardels quotes psychologist W.K. Penzer, who feels that centralized word processing is demoralizing and dehumanizing. Penzer points out that "while managers in manufacturing concerns strain to right the job design wrongs of yesterday, their administrative counterparts move just as steadily toward the specialization of office and clerical jobs in the guise of efficiency and cost reduction."

Finally, in considering the application of stand-alone, decentralized work stations to aerospace, we must recognize the following:

1) This approach seems most popular in research laboratories where the scientist or engineer generally has his preferences respected. Hence, the technical author's natural desire to control the accuracy and content of the report tends to be complied with.

2) In this environment, where deadlines, publication quality, format consistency, throughput speed, etc., are less important than the technical quality of the report, decentralized work stations tailored to specific applications do not seem necessarily inefficient.

3) One of the often heard arguments in the research environment is that because accuracy and technical quality are paramount, it is preferable that the technical author enter the material, even pecking away with one finger, and avoid the inevitable errors introduced by editors and operators.

4) Where better technology in stand-alone systems is needed is in the ability to produce a better-looking and more accurate report by handling complex mathematics, tabular material, statistical data, special symbology, and so forth, at relatively simple-to-operate work stations. The introduction of the double-element printer for example, with its expanded character set, may well make this capability a reality. Such features as proportional spacing, half-space ratcheting for subscripts and superscripts, and so forth, are also desirable in the technical environment, but are not always available.

One further comment is necessary on stand-alone systems. Keith Wharton, of Keith Wharton Consultants, Ltd., Kew, Surrey, England, presented a paper at the AGARD TIP conference on computer-assisted editing in Paris, in which he described his consulting assistance to Redifon Flight Simulation of England in automating one of their publications programs (3). Redifon had to produce a large series of typeset manuals to U.S. Air Force Specifications, with extremely tight schedules. Their current manual techniques could not handle the load, and they were reluctant to enter into the investment in time and money required for a shared-logic system without some experience in text processing and publishing automation. With the assistance of Keith Wharton's group, they developed an approach based on using Wang 1222 stand-alone typing stations. These vdu terminals were equipped with a TTS-coded paper tape punch, which produced an output capable of driving a phototypesetter (see figure 4-3). Hence, we see an example of less sophistication than might be warranted used as a first step, providing a relatively inexpensive way of educating an organization to the benefits of automation.

4.2 MINICOMPUTER SHARED-LOGIC SYSTEMS: THE BASIC BUILDING BLOCKS

This section of the report should, perhaps, be of most interest to the medium-sized aerospace user in that it suggests how standard available equipment (although in some cases, quite sophisticated equipment) is used as building blocks to set up a basic system and then, as necessary, the system's capabilities are expanded by adding more modular units. The power inherent in currently available small computers makes this kind of approach possible. The specialized requirements of technologically oriented organizations, as well as the technical strength available in such organizations, makes such imaginative approaches probable. The groups we looked at have differing requirements and used differing approaches to answer their needs, but the basic building blocks they started with are remarkably similar.

4.2.1 *Honeywell Information Systems (HIS)*

Honeywell Information Systems (HIS) has built its automated publications system around the Omnitext 1500 editing terminal. The Omnitext terminal is one of the more flexible stand-alone terminals in that its computational capability, in its largest configuration, is quite high enough to permit a second Omnitext "slave" terminal to operate off the same logic and, at the same time, handle various peripheral devices. Moreover, it accepts a variety of input devices: tapes produced by various stand-alone word processing terminals, such as MT/ST; direct keyboarding at the master or slave terminal; punched paper tape; or ocr, using machine-readable copy provided by IBM Selectric typewriters equipped with elements that produce a special ocr-readable typeface. Thus, Omnitext offers the user the ability to move up gradually from what is already there, and add complexity and sophistication as the need arises and the economics of the situation permit. It is with this approach that HIS went into publications automation.

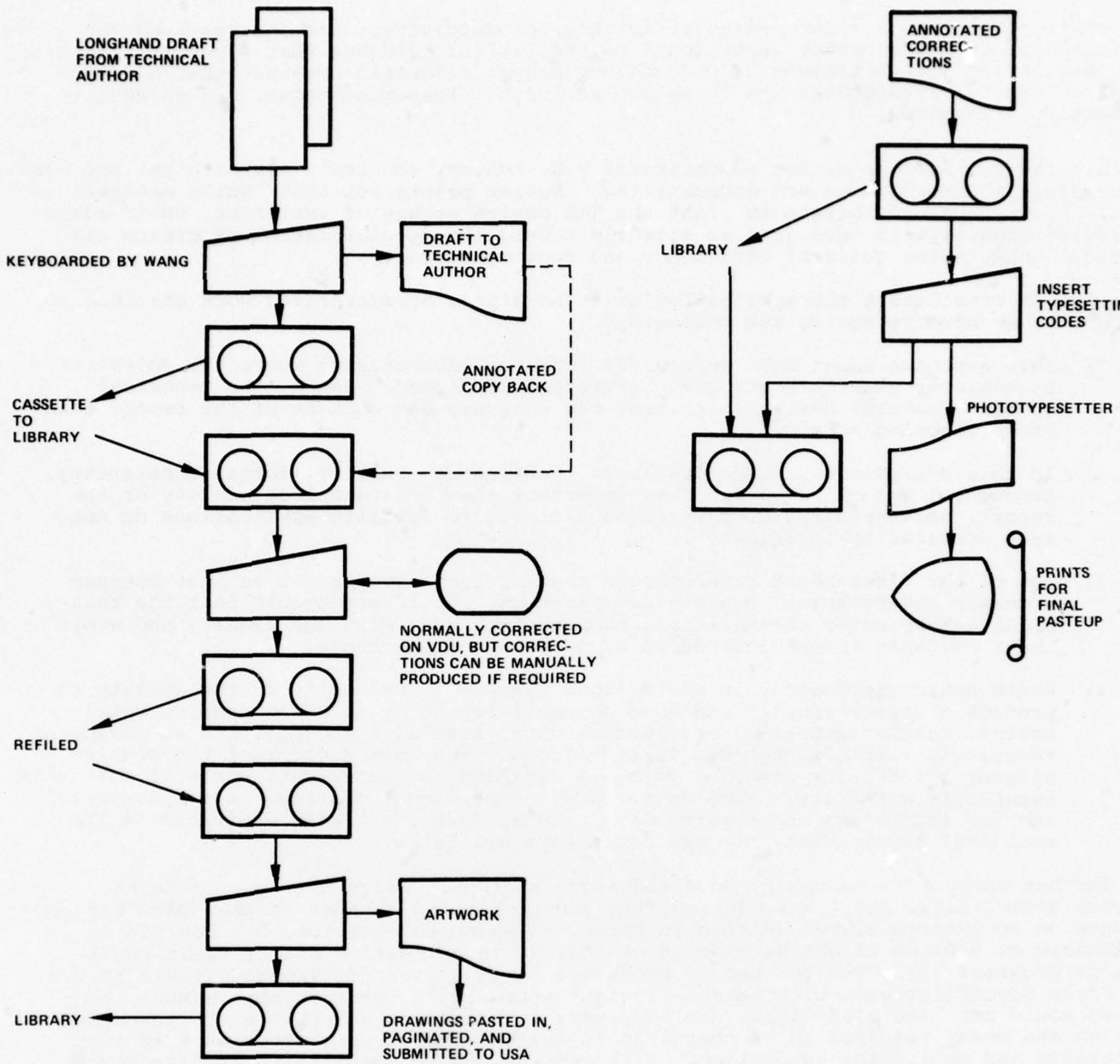


Figure 4-3. Flowchart for Preparing Redifon Manuals

The information on HIS is derived from a presentation given by Mr. Edward G. Mitchell of HIS at the Computer Assisted Editing and Composition Seminar, sponsored by the Boston Chapter of the Society for Technical Communication on 26 September 1975 (4), an article on the facility in *In-Plant Printer*, May 1976 (5); and conversations with Mr. Mitchell and Mr. Richard Harris of Omnitext.

For several years, HIS had been preparing copy for many of its product-support publications on proportional and monospacing typewriters, with generally good results. However, with increasing volume, certain limitations became apparent:

- Material had to be keyboarded at least twice, and frequently more often.
- The resulting copy did not make optimum use of the space on the page.
- It was difficult to train and keep personnel with the necessary skills.

These factors indicated the need for more automated techniques. In 1974, a team under the direction of Mr. Mitchell, manager of graphic services, began defining what was needed. After evaluating the alternatives, they came up with a totally new system. Its prominent features are as follows:

Input. - The primary input device is an optical page reader (ocr machine), which accepts copy prepared on Selectric typewriters that have "golf-ball" type elements that generate ocr-readable copy.

Processing. - The storage, editing, and formatting functions are accomplished on three vdu editing work stations, built by Omnitext, Inc.

Output. - The final primary output is a phototypesetting machine, a multifont-multisize system built by Mergenthaler. IBM Magnetic Tape Selectric Composers (MT/SC) provide supplementary output capacity.

In addition to this basic equipment, certain peripheral devices were included, such as a medium-speed proofing printer and a magnetic tape transport to permit magnetic-tape input when appropriate.

The system was implemented in three distinct phases, as follows:

Phase 1. - In this stage, the front-end equipment (ocr and editing equipment) was installed and functionally integrated with the MT/SC output system (see figure 4-4).

Phase 2. - The main addition in this phase was the phototypesetter. Processing capacity was expanded in the form of more editing terminals and disk storage (see figure 4-5).

Phase 3. - The final stage is the tie-in of material produced in Honeywell's Phoenix, Arizona facility, and forwarded to Waltham, Massachusetts, on magnetic tape (see figure 4-6). Note that ocr material is produced at two HIS locations: Billerica, Massachusetts and Waltham, Massachusetts.

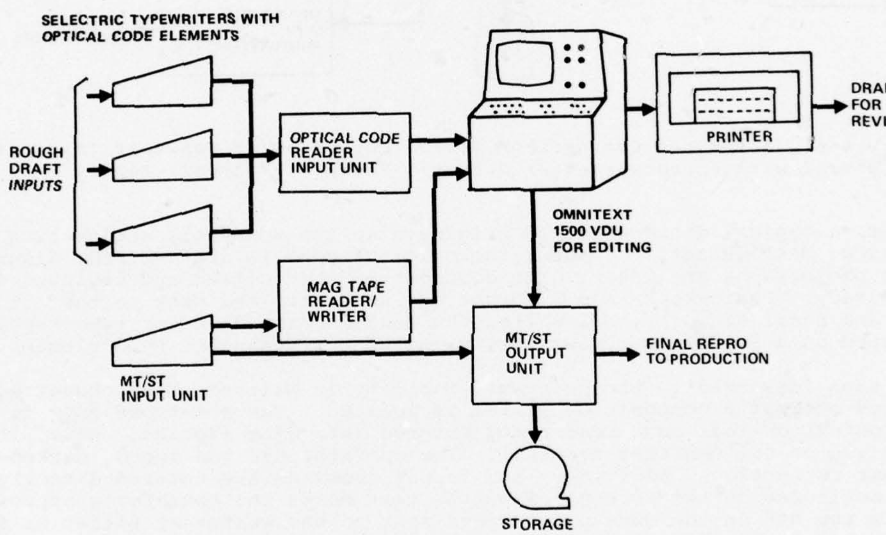


Figure 4-4. Minneapolis-Honeywell: Phase 1 - Omnitext Input and Control with MT/SC Output

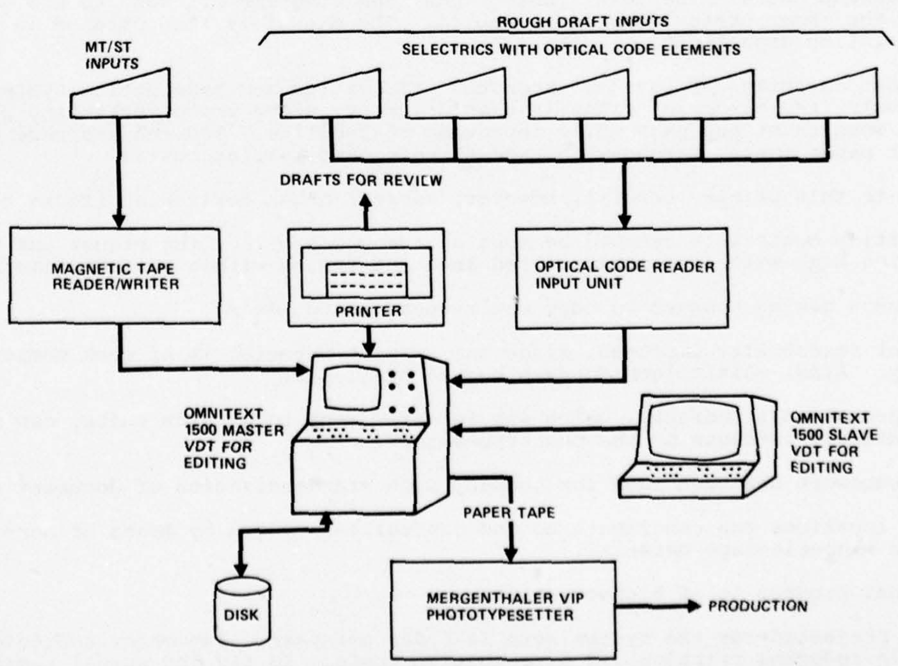


Figure 4-5. Minneapolis-Honeywell: Phase 2 - Omnitext Input and Control with Photocomposition Output

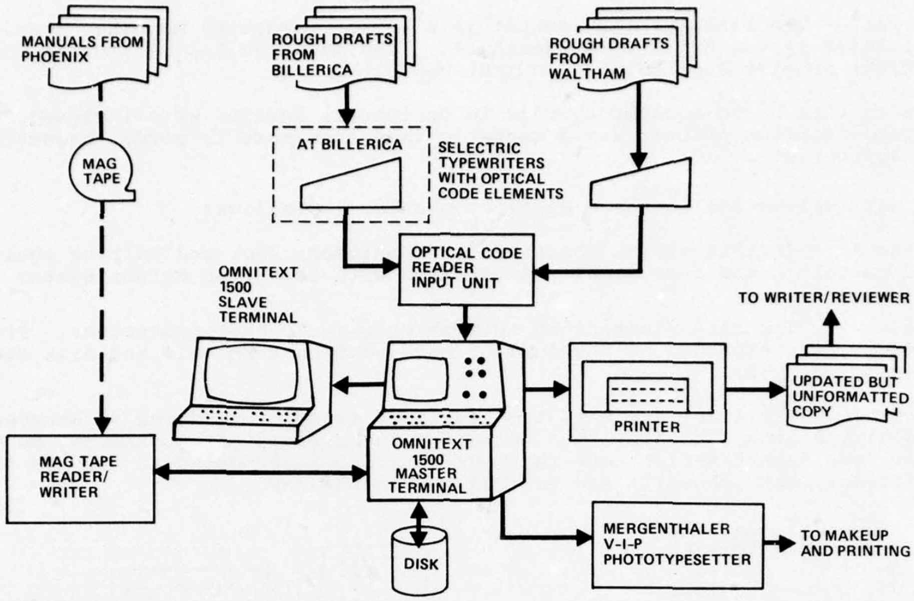


Figure 4-6. Automated Composition System Copy Flow of Omnitext Input and Control with Phototypesetter Output: Phase 3 - Phoenix Inputs

In this system, a typical document could originate in the Honeywell engineering facility in Billerica, Massachusetts. There, the original copy is draft-typed, diagrams are sketched, and photographs are taken. The document is then edited and reviewed for technical accuracy. Photographs and diagrams are separated and sent to the art department for clean-up and final artwork. Meanwhile, the text is marked up for typographic format and typed on a Selectric typewriter, using an ocr-scannable type element.

The draft is then forwarded to the Honeywell facility in Waltham, Massachusetts, where the centralized automated composition system is located. The ocr-typed copy is run through the Context optical page reader and entered into disk storage. Next, it is reviewed on a vdu on the Omnitext terminal. The operator has the typed, marked-up copy in hand so that corrections, additions, and format commands are entered directly at the terminal and monitored on the screen. When the text meets the operator's approval, a review copy is run off on the Qume printer and sent to the writer at Billerica for approval. Punched paper tape (6-channel, TTS coded) is produced at the Omnitext terminal to drive the typesetting machine (a Mergenthaler V-I-P). Headlines, titles, callouts, and footnotes can be set directly in place, eliminating a substantial part of the usual pasteup chore. The text, photographs, and diagrams are sent to the pasteup area, where the camera-ready copy is assembled. The manual is then printed in the Honeywell printing department.

The major cost advantage of the new automated composition and typesetting system has been in reducing the number of pages in each document, since phototypesetting permits a much higher word count per page while improving readability. The reduced page count led to lower paper costs, warehousing, and shipping and mailing costs.

In addition to this primary benefit, however, several other desirable effects occured:

- Composition costs were reduced because of the speed of ocr techniques and the resulting high volume of material fed into the system within a given time frame.
- Time spent making changes to copy was reduced using vdu's.
- Document readability improved, since the typeset material is of book composition quality. Also, multicolumn formats became available.
- Sales-promotion typography, which was formerly sent to outside shops, can now be done entirely in-house on the phototypesetter.
- The groundwork has been laid for company-wide standardization of document style.
- Remote locations can contribute to the centralized system by means of ocr-scannable copy or magnetic-tape material.
- The final product is of higher quality.

The savings projected for the system were $336,000 per year. The major source of these savings is in reducing printing and distribution costs. So far the actual savings are running ahead of projection.

It is difficult to assign an economic value to the intangible benefits of this type of system, such as standardizing the material originating in scattered locations and in different major divisions of the company, or delivering better-looking products to the company's customers. However, Honeywell believes that these benefits of the new composition/typesetting system will prove significant in years to come.

4.2.2 *Raytheon Service Company (RSC)*

Raytheon Service Company (RSC) also selected Omnitext as a central building block but, based on its needs and the available equipment, chose a different configuration. This description of RSC's automated publishing operation is based on a presentation given by L Stoddard at the Society for Technical Communications Seminar in Boston on 26 September 1975(6), and on a visit to RSC by Lockheed personnel on 30 June 1976.

The word processing center at RSC contains all the equipment necessary to produce high quality documentation. High quality documentation was the reason given by both Mr. Stoddard and Mr. Gene Kelly, of the Technical Publications Department, for buying the Omnitext system and peripheral equipment. They believe Omnitext is one of the few systems that can grow with both the changing trends in word processing and the higher quality required for technical publications. In RSC's center, there are two Omnitext master terminals and two auxiliary, or slave, terminals and ocr equipment (see figure 4-7). In addition, they bought a Graphic Systems phototypesetter. In another room, operators input material at stand-alone Selectric typewriters. An ocr type element produces sheets with codes under each character. These elements are inexpensive (about $35), and make any Selectric terminal a potential inputting station. The sheets are fed into the computer, and can be called onto the display screen. A paper tape is punched for inputting to the phototypesetter. This is the primary way to use the Omnitext system. A secondary way is to input both characters and codes directly into the computer at the terminal to create punched paper tape, which is then read by the phototypesetter. (Overall system flow is similar to that described in paragraph 4.2.1.) Text is corrected and manipulated on a crt display terminal and outputted on either a line printer for review drafts, or the photocomposition device for final output.

RSC system components include:

- One optical character reader (Taplin).
- Two master terminals (includes cpu, keyboard, and vdu).
- Two slave terminals (includes keyboard and vdu).
- Two 12-million character disk storage units.
- One line printer.
- One photocomposer.
- Software package.

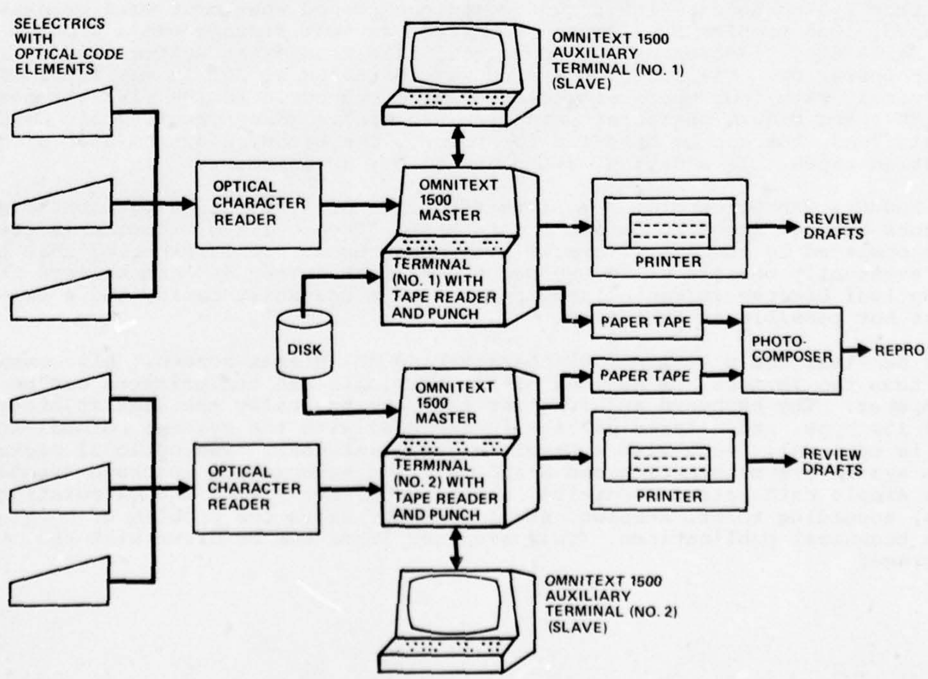


Figure 4-7. Raytheon Editing and Photocomposition System

A system with four processing terminals and a staff of two editorial assistants, five technical typists, and four proofreader/pasteup people can do the work of 14 technical typists, four proofreaders, and three pasteup people plus produce 10,000 pages that were previously prepared by vendors.

Omnitext, as described in paragraph 4.2.1, is a system for producing camera-ready pages from original typewritten copy, without rekeyboarding as material goes from draft to final stages. Any Selectric typewriter equipped with an appropriate ball is used to prepare the original draft. The draft is then optically scanned and stored for later use. A line printer provides hard copy for editing and revision. Any changes and editorial corrections are made on a special vdu by changing only the word, sentence, paragraph, or page impacted. Final pages are produced by phototypesetting directly from the updated material.

In summary, Omnitext was acquired by RSC for the following reasons:

- Protect present business and expand business base to:
  - Decrease in-house labor cost per page.
  - Increase in-house composition capacity.
  - Meet tight, demanding schedules at lower cost by reduced high-cost vendoring and reduced overtime.
- Improve commercial and other fixed-price business by:
  - Lowering the cost per page.
  - Storing customer's information in system.
  - Increasing production capability to permit rapid response, without recourse, to high-cost verdor service.
- Lower costs of technical manuals by reducing page composition costs.
- Reduce costs of proposals by:
  - Storing reusable information.
  - Using original typing as system input.
  - Eliminating redundant proofreading.

4.2.3 *Jet Propulsion Laboratory (JPL)*

This description of the Jet Propulsion Laboratory (JPL) facility is based on a visit to JPL, where an LEC representative discussed automated publications with John Kempton, Manager of the Publications Section and Robert M. Van Buren, Supervisor of the Editorial Group. The JPL publications section uses the Daconics shared-logic system. The department bought this system because their requirements exceeded what most word processing systems offered. One problem Mr. Kempton detailed was that storage was a problem with the IBM Mag Cards they had been using, and a good file management system is very important to their operation. The Daconics system was installed at JPL in May 1976. There are five terminals with four operators, one computer connected to the five terminals, and three high-speed Diablo character printers (400 wpm). These printers are hard-copy continuous pin-feed, but can be hand-fed for forms. The Daconics system also produces photocomposition tapes. In addition, JPL plans to buy an ocr device.

Mr. Kempton and Mr. Van Buren stated an inputting rate of 3,000 pages per month; some classes of jobs are new input to obtain a data base. They believe Daconics is cost-effective as compared to the APS 12 system previously used. It is expected that the system will eventually operate at 10,000 pages per month. They did not believe the system was optimal because it was only being used on a one-shift basis, and a two-shift operation was not possible at that time.

The Daconics terminal has a 40-line, 85-character (wide) plasma screen. All commands are no more than two letters. A maximum of ten terminals and ten printers can be used with one computer. The keyboard and function keys are basically the same as other equipment of its type, and a forms package is included with the system. Global search and replace is optional, along with a Greek letter printwheel. Two optional packages in the Daconics system are mathematics and graphics. The mathematics package automatically does simple mathematics (addition, subtraction, etc.) with the calculating key. This package, according to Mr. Kempton, still does not solve the problem of complex equations in technical publications. Only straight lines can be drawn with the graphics package.

4.3 LARGE-SCALE COMPUTER-BASED SYSTEMS

For any aerospace organization that has the size, volume of material, available assets, and continuity of workload, no approach to automating text processing and publishing offers the flexibility and growth potential of systems based on large-scale general-purpose computers. Aerospace companies in particular have pioneered in developing and applying such systems, for a variety of fairly obvious reasons:

1) Their products are generally expensive, complex systems produced to last for many years.

2) Their systems are usually modified throughout their life-cycles to accommodate changing requirements and advances in technology. Documentation must therefore change as the hardware changes.

3) There is generally continuity of support responsibility for aerospace systems. Hence, an organization can reasonably assume that an investment in computer-aided facilities will be worthwhile in terms of meeting future requirements for documentation updates.

4) The sheer volume of paper that must be prepared and continually revised to support a modern aerospace system in its many configurations makes computerized documentation systems almost a necessity.

In the paragraphs that follow, we will consider four representative systems -- one designed for the Polaris/Poseidon/Trident missile systems, one for the Boeing 747 aircraft, one for an airline's maintenance publications, and one for a U.S. Navy installation charged with updating and publishing large amounts of data. Lockheed's Autotext System will be described first and in most detail since it is one of the most comprehensive, and many of the capabilities are obviously translatable to any large-scale publications system.

4.3.1 *Lockheed Missiles and Space Company (LMSC) Autotext Publication System (APS)*

a) *General Description.* - The Lockheed Missiles and Space Company (LMSC) Autotext Publication System (APS) is a computer-based text-composition system that provides computerized text processing of publications such as technical manuals, reports, and engineering specifications. APS uses third-generation computers and peripheral equipment to produce formatted documents, and uses magnetic tape to drive a phototypesetter to create camera-ready copy (see figure 4-8 for data flow). APS was implemented at LMSC in 1968 to support the preparation of C3 Poseidon Fleet Ballistic Missile technical manuals (7).

APS is an outgrowth of a Computer Assisted Manual Preparation (CAMP) system developed at Lockheed-Georgia Company, with major assistance from RCA. CAMP was developed to publish C5A Galaxy technical manuals. System design, initial programming, and testing were done at Marietta, Georgia, from 1962 to 1968. LMSC elected to use the CAMP system as a base for implementing a system to support C3 Poseidon documentation. Major changes were made to CAMP to meet LMSC's requirements. The real-time (data-collection) system became operational in July 1968, and the output generation system produced the first phototypeset output in November 1968.

Hardware. - APS was originally implemented on a dedicated RCA Spectra 70/45 with 262k bytes of memory. In late November 1970, a conversion effort was begun to move the system to the main Administrative Data Processing Center's two IBM 360/65's. The conversion was completed and the Spectra was released in May 1971. The Administrative Center's 360/65's have since been upgraded to two 370/165's with 3-million bytes of memory each. The storage for real-time files and batch-processing work areas is on Telex 2314 and 3330 disk-storage devices shared by the two systems. Approximately 50,000 active pages are currently on-line. Multiple magnetic-tape stations are available to both systems for print files and to provide an off-line interface with a Mergenthaler Linotron 505 phototypesetter and Information International, Inc. COMp80 microfilm recorder. On-line upper- and lower-case high-speed printers are used for rapid printing of APS proof copy.

Over 200 terminals are on-line to the LMSC real-time system and can be allowed access to APS. The 2740/2741-type terminals (actually Trendata equivalents) and the newer Trendata 4000 (35 characters per second) terminals are used. Of the 200 available terminals, the terminals used primarily for the Autotext workload are on a two-shift basis to support the current production.

Software. - APS is an integrated system comprised of four major subsystems:

. Data entry/update.

. Output generator.

. File management.

The *data entry/update subsystem* is a real-time system providing access to an on-line draft file through 2740/2741-type terminals. Data may be entered, deleted, changed, moved, copied, or retrieved via this system.

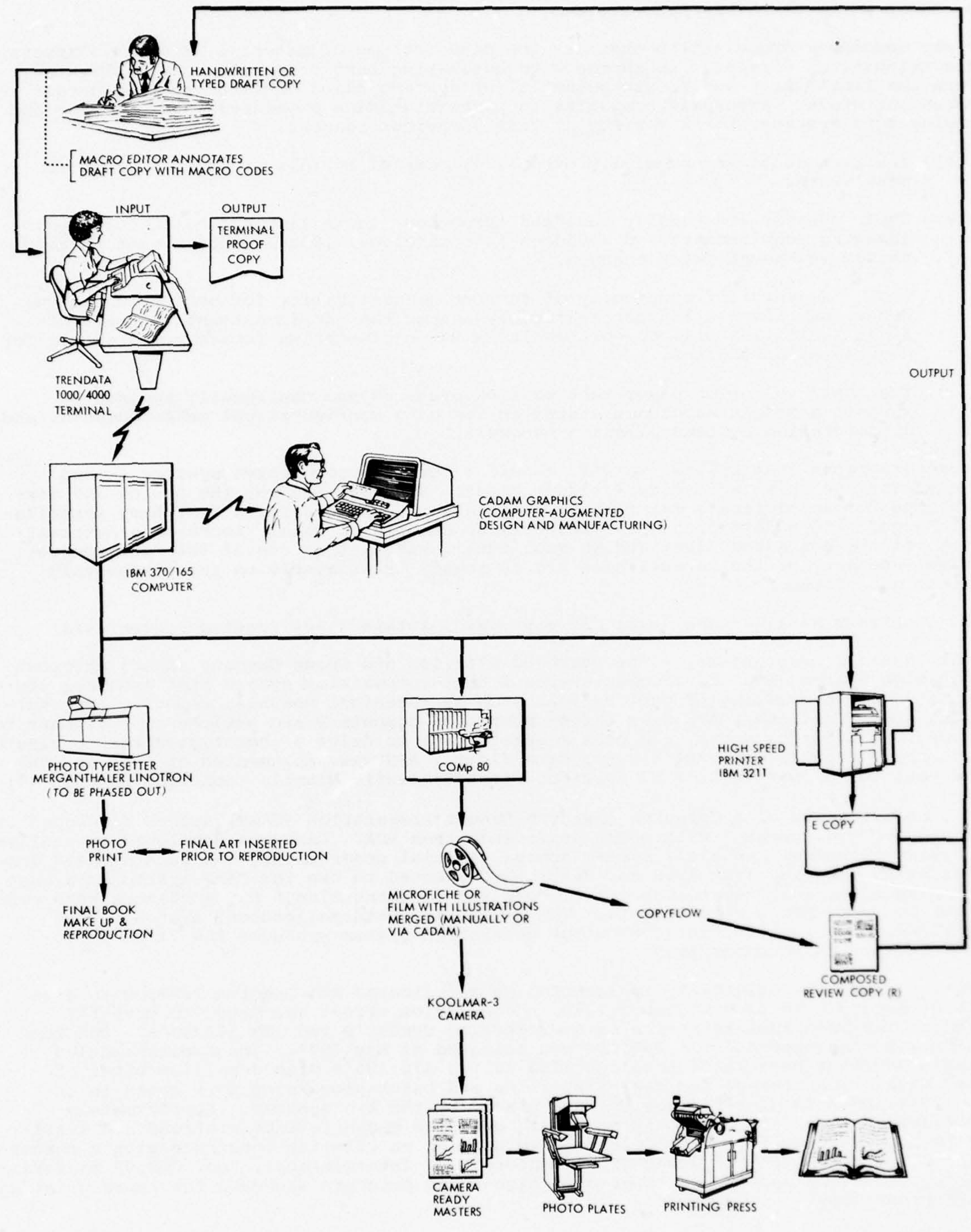


Figure 4-8. Lockheed Missiles and Space Company Autotext Data Flow

The *output generator subsystem* is a text composition system, currently operating in a batch mode, which extracts data from the on-line draft file and produces, upon request, the following outputs:

- Noncomposed proof copy (A-report).
- Partially composed proof copy (S-report).
- Composed proof copy (B-report).
- Composed and typeset final copy.

The A-report is printed on a line printer. It is proof copy of the data as it appears on the draft file, including all format specifications and control commands, with draft file addresses adjacent to each sentence. The S-report may be produced in conjunction with an A-report. It is partially formatted according to formatting instructions. Format and control commands are not printed; the only address printed is the starting address of each output page. This proof is intended for content review and limited proof of galley format. The B-report may be printed on a line printer, and shows line resolution and page makeup as it appears on final copy, within restrictions imposed by line-printer capabilities. The B-report may also be produced on the COMp80. In this case, the output is identical to final copy without merged illustrations, or complete with illustrations drawn from the Computer Augmented Design and Manufacturing (CADAM) System. The final copy is a phototypeset, fully composed, paginated document that includes a table of contents, list of illustrations, index, etc.

The *file management subsystem* performs the following functions:

- Moves inactive documents to off-line files.
- Brings previously inactive documents back to on-line draft files.
- Retains multiple cycles of volatile documents.
- Provides storage for *last published* version of a document (exactly as published), allowing subsequent "Change-Page-Only" publication.
- Provides reorganization and backup for on-line draft files.
- Provides management reports on document title, author, size, lost activity datlast activity date, file location, etc.

b) *System Capabilities.* - The capabilities of LMSC's APS system represent the degree of sophistication achievable by using large-scale computer-based systems, with their inherent flexibility and growth capability.

Text processing. - Text processing, compared to illustration or table processing, is relatively simple and presents very few problems in APS. Justified text can be set in either single- or double-column format with certain restrictions:

- Baseline leading must be constant within a page.
- Page length must be constant within a chapter.
- Only first-order inferiors and superiors can be used.

Justification. - APS is designed to produce essentially hyphenless justification by distributing positive or negative adjustments across both word and letter spaces. Since the early Linotron 505's had very poor letter-spacing capability, the techniques used are somewhat crude. However, it is still possible to achieve acceptable virtually hyphenless output for line lengths of 15 picas or more in type sizes up to 12 points. The COMp80, with its finer space-adjustment capabilities, has practically eliminated the need for hyphenation for line lengths of 15 picas or more.

Widow Line Control. - The first or last lines of a paragraph are not allowed to be widowed from the rest of the paragraph across pages or columns.

Restricted Text. - Certain blocks of text must not be split across columns or across pages. We refer to this text as "restricted." APS allows users to apply text-splitting restrictions to such blocks of data and still allow full-page composition. The most prevalent use of this feature is for caution and warning notes in military publications.

Column Balancing. - At a normal page interruption, such as at the end of a chapter, a short page may be generated. If double-column text is being set, the two columns are balanced. When double-column data is interrupted by single-column data, the double-column data is set in two balanced columns.

Illustration Space Reservation. - Space may be reserved for illustrations in terms of quarter-page, half-page, column, or full-page. Foldout illustrations are provided for by reserving a right page and leaving the left backup page blank. Twist or turn pages are also commonly used. If a figure number and title is supplied with the space-reservation request, APS centers the figure number and title at the bottom edge of the space reserved for the illustration. If a list of illustrations is requested, the figure number and title are extracted for this list.

Illustration Handling for Linotron Output. - APS reserves white space on the Linotron 505 phototypeset output. The Illustration Request (IR) number is centered in the reserved space. The phototypeset masters go to Book Makeup, where the illustrations are pasted down.

Illustration Handling for COMp80 Output. - When COMp80 final copy is requested and illustrations are to be merged, slides of all illustrations are prepared and sent, with the magnetic tape containing the text, to the COMp80 for processing. When an illustration callout is encountered on the text tape, the COMp80 calls for the correct slide. When

the slide is inserted, it is merged onto the film output. An interface with the CADAM system provides the use of CADAM-created drawings in APS documents. In this case, both the text and illustrations are fully digital. Examples of CADAM-created illustrations are shown in figures 4-9 and 4-10.

Table Titles. - Table titles are extracted for the list of tables when it is requested. A table title, normally in all capital letters, is placed at the beginning of a table. If the table overflows to other columns or pages, APS repeats the title in initial capital letters with the word (Continued) appended. Table boxheads are also repeated.

Ruling Styles. - APS provides the user with the following six standard ruling styles:

. Vertical rules between columns and at left and right margins. Horizontal rules before and after boxheads, at the end of table and between sets.

. No vertical rules. Horizontal rules before and after boxheads and at end of table.

. Vertical rules between columns and at left and right margins. Horizontal rules before and after boxheads and at end of table.

. Vertical rules between columns. Horizontal rules before and after boxheads and at end of table.

. Vertical rules between columns. Horizontal rules before and after boxheads, at end of table, and between sets.

. No rules.

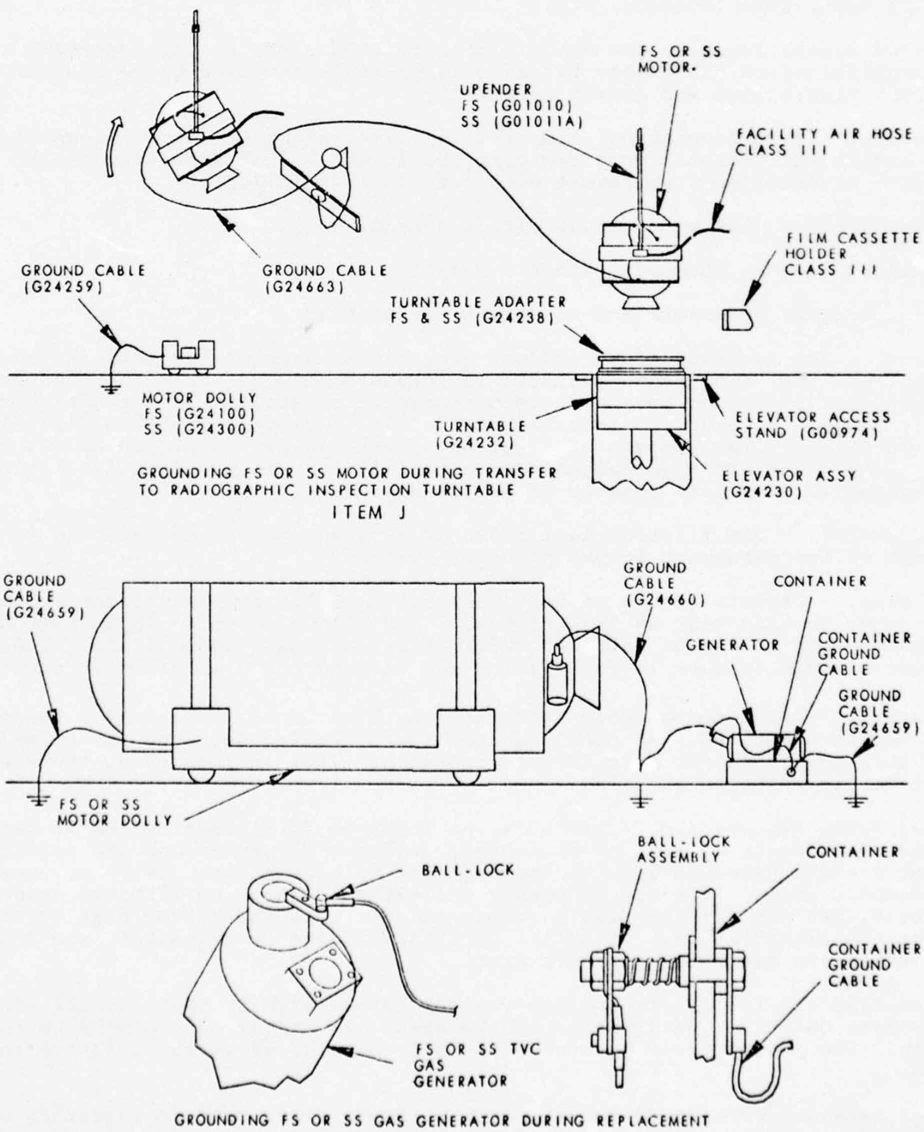


Figure 4-9. Typical Computer - Prepared Illustration, Using CADAM

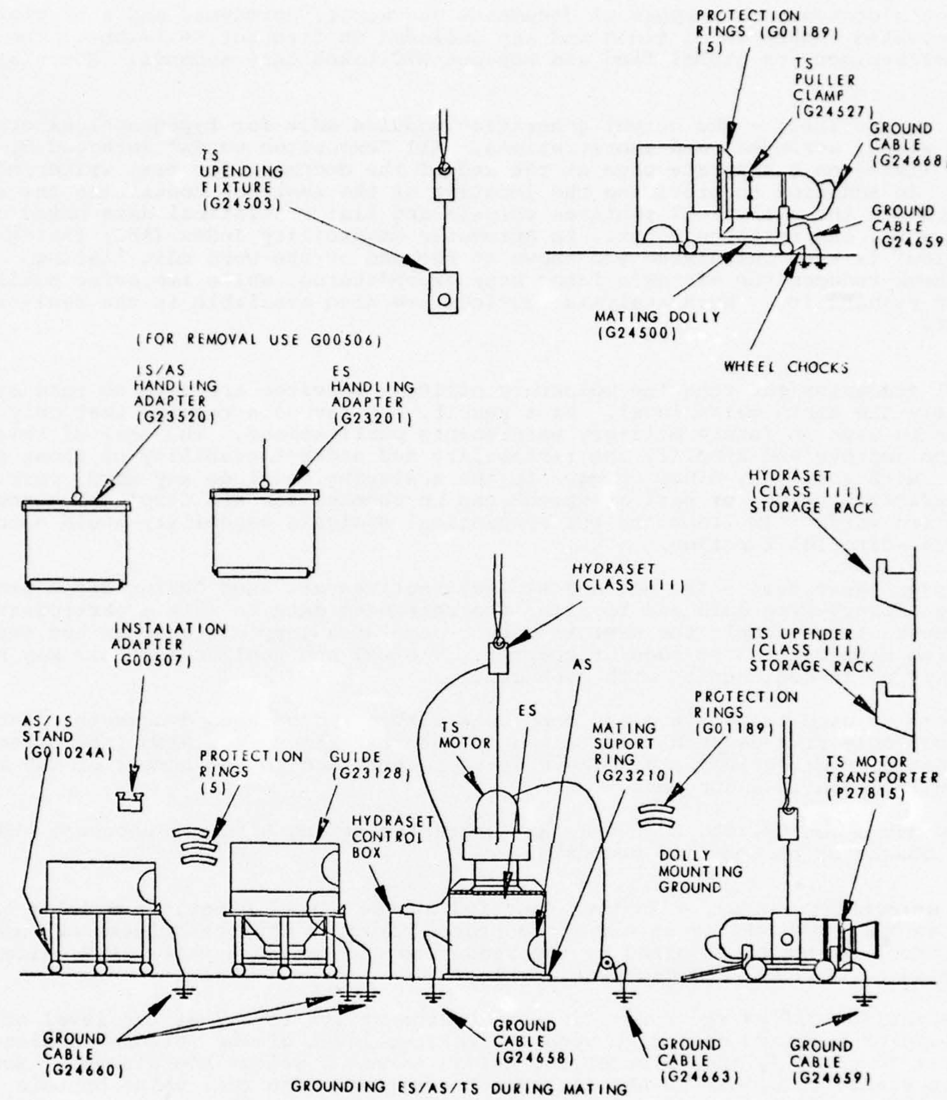


Figure 4-10. Typical Computer - Prepared Illustration, Using CADAM

Tabular Data Formatting. - APS has a wide variety of tabular-data formatting capabilities. Data may be left-justified, right-justified, or centered within a column or across a group of columns.

Automatic Assemblies. - An automatic assembly is an assembly generated by the system, on request, and merged back into the text stream at a user-specified location. The data selection, merging, and format of an automatic assembly for a given book type is controlled by the macro table for that book type. The automatic assemblies currently available to APS users are the table of contents, list of illustrations, list of tables, subject index, and key-word-in-context (KWIC) index.

Page Composition. - The page composition modules analyze leading requirements, splitting restrictions, widow-line indications, single- and double-column indications, header callouts, space reservations, etc., to format single-column, double-column, or mixed single- and double-column pages.

c) *Editorial Assistance.* The paragraphs that follow provide a description of APS editing capabilities.

Global Find and Replace. - In addition to reducing operator labor, the global find and replace Real Time Command (RTC) also reduces writer and editor labor while improving the document's quality assurance. For example, the LMSC Company-Union agreement was recently renegotiated. The settlement specified that the word *leadman* be changed to *leadperson.* By using one RTC, all 78 occurrences of the *leadman* were changed to *leadperson* in milliseconds. No proofreading was required to locate all occurrences. No words were missed. The same change was not typed 78 times, correctly or otherwise. The quality assurance check was limited to the 10 to 15 seconds required to verify the accuracy of

the operator's change. Many types of documents use words, acronyms, and abbreviations that are repeated thousands of times and are included in frequent revisions. The global find, global replace, or global find and replace RTC takes only seconds. Hours are saved.

Word Analysis Routines. - The output generation modules edit for typographical errors, misspelled words, acronyms, and abbreviations. All "exception words" detected by the system are listed on a separate page at the end of the document for easy writer/editor reference. In addition to providing the location of the sentence containing the exception word(s), the analytical routines compile and list statistical data based on character, word, and sentence count. An Automatic Readability Index (ARI) factor (explained below) is then calculated and shown at the end of the word edit listing. The spelling check reduces the editor's labor hour expenditures, while improving publication quality and readability. Word analysis routines are also available in the real-time environment.

High school graduates entering the voluntary military services are said to read at approximately the ninth grade level. As a result, DoD may soon require that only specified verbs be used in future military maintenance publications. The goal of this effort is to improve and simplify the readability and understandability of those publications. With some very minor changes to the analyzing routines any word, verb, adverb, character string, or part of speech can be checked for and displayed along with the misspelled words. Implementing the syntactical analysis capability would automate a very tedious editorial function.

GET and Replace Routines. - The GET and Replace routines are used during batch processing to retrieve library-type data and to alter the retrieved data to suit a particular application. The routines enable the user to copy a page or a complete chapter and replace any specified data within the page or chapter. The GET and Replace routines may be used independently or in conjunction with each other.

The GET macro is used to retrieve and copy data within and between documents. Data can be copied not only from documents contained in Autotext files, but also from other files such as Finance, Engineering, etc. There is no restriction to the number of GET macros that can be inserted in a document.

The Replace macro can be used to change any character string within a document and replace that character string with new data.

Automatic Readability Index. - Another function of the output generator modules is to calculate an ARI. The ARI is an Air Force created formula that calculates the number of years of formal education required by the reader to understand a page. APS calculates ARI at the page, chapter, and document level.

The ARI, sometimes called *fog count,* is used by the writer to adjust the level of writing either upward or downward depending upon the reading level of the intended audience. It is difficult to quantify the value of the ARI in terms of writer hours saved. Normally, a writer is unable to assess an ARI for what is written. The real value of this feature lies in the improved performance of maintenance personnel resulting from a higher quality and more effectively written maintenance publication.

Advantages. - Applying APS to the LMSC publication production cycle has resulted in the following advantages:

- Revised review copies overnight.
- No retyping or reproofreading of unchanged material.
- Automatic formatting.
- Special symbols for equations and special applications.
- Low-cost storage of material.
- Rapid, low-cost retrieval of stored information.
- Ability to move data from one document to another.
- Efficient assembly of tables.
- Automatic pagination and change repagination.
- Automatic assembly of table of contents and list of illustrations.
- High-speed phototypesetting.
- High-quality final masters.
- Wide selection of type fonts.

- More text per page.
- Elimination of manual filing system for storage.
- Automatic indexing of paragraph headings, and table and figure titles.
- Automatic word analysis.
- Word (global) search and replace.
- Automatic readability index.
- Typing 20 percent faster (minimum).
- Reduced writer time.
- Reduced editor time.
- Reduced proofreading time.

Disadvantages. - Experience has shown that large-scale systems such as APS are not particularly advantageous to use on: 1) documents less than 15 pages in length, which do not require initial generation reviews and 2) existing documents that are not subject to several revisions before the end of their life cycle. Moreover, on those large documents prepared for microfilm output, halftones are not used at all and foldouts are limited to 17 inches in length to accommodate the microfilming system.

4.3.2 *Boeing Automated Publishing System (APS)*

Boeing's Automated Publishing System (APS), like Lockheed's Autotext System, is based on a large-scale general-purpose computer. It is interesting in that it was developed for a commercial, not a military application, indicating that such systems can be cost-justified in a competitive environment. Second, it was developed not for the many generations of similar equipment, but for the varied configurations of a single aircraft: the Boeing 747. Third, its growth from a text-only system to an exceedingly sophisticated system for handling graphics is another indication of the inherent flexibility of such systems. For the descriptions of this system, I am indebted to a paper presented by Mr. W.G. Moss of Boeing (8) at the Aerospace Industries Association (AIA) and Air Transport Association (ATA) Joint Symposium on Automated Publications at Scottsdale, Arizona on 20 May 1976, and to various internal Lockheed trip reports prepared by Mr. H.G. Maxwell of the Lockheed-Georgia Company, Marietta, Georgia.

Boeing's initial studies on an automated publications program began in 1971. Development proceeded in two major phases. APS-1 involved only the automation of text production. Like Lockheed's Autotext, it features real-time input of text, batch processing, and photocomposed output. Automatic pagination, automatic step numbering (if a step is added or deleted, all successive steps are automatically renumbered), automatic revision bars, and an automatic list of effective pages are provided. Illustrations are produced conventionally and pasted into spaces left in the text. This system has been in operational use since late 1973 (see figure 4-11).

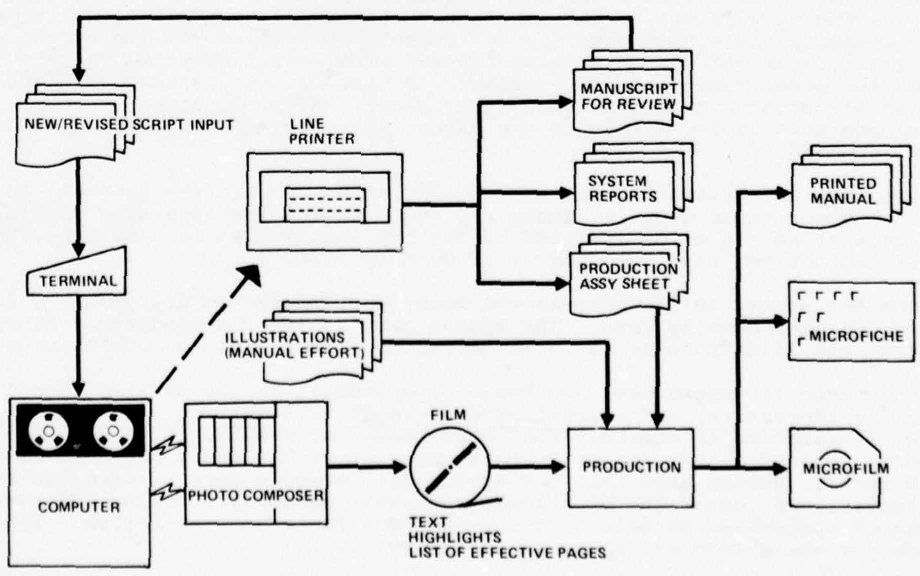


Figure 4-11. Boeing APS I Text Flow (First Stage)

APS II began in November 1973 with a study of the ways in which to improve the production and storage of illustrations. Boeing says that the objectives were to:

. Decrease illustration costs.

. Increase illustrator productivity.

. Improve quality.

. Reduce flow cycle.

The productive use of APS II for producing new illustrations began in January 1976 (see figure 4-12). The computerized storage of old illustrations requires a scanner, which was scheduled for installation in 1976. The total implementation of the system was expected to be completed by the end of March 1977.

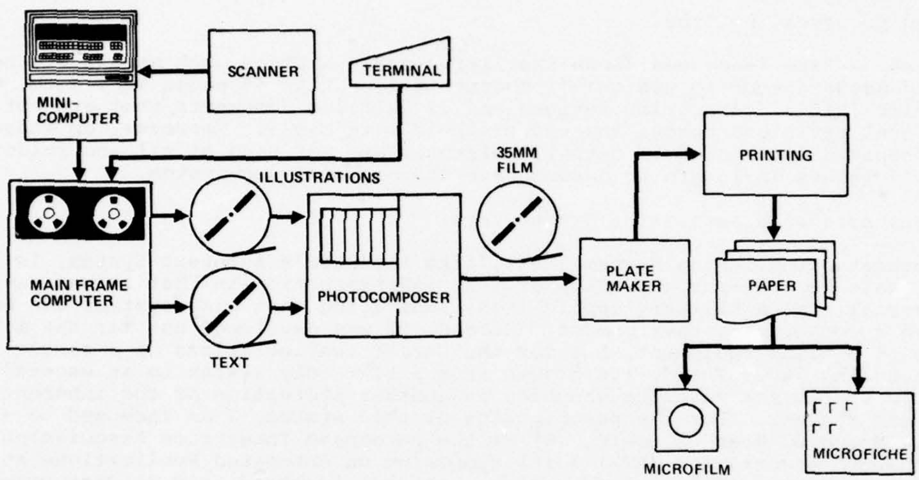


Figure 4-12. Boeing APS I and APS II Integration (Second Stage)

There are 14 interactive input terminals at Boeing in three geographic areas with a total separation of about 30 miles. The system was designed by Applicon in Massachusetts. It is used to create new illustrations, and has an on-line capacity of approximately 1,000 illustrations. One feature is symbol recognition for commands. Instead of keyboarding all commands, the operator may choose to use the light pen for some of them. For example, the user can draw a circle around a particular portion of the illustration and program the system to respond by immediately clearing the screen of everything outside the circle. The operator can also work with multiple orthographic views at the same time. As one view is drawn, the computer generates the corresponding trace in a second. On command, the system displays all three orthographic views plus an isometric view. The illustrator can continue to modify any view, and the system can simultaneously change the other views and the isometric to conform. Boeing says it takes about 6 months for an illustrator to become thoroughly adept. After 3 months, however, the illustrators are sold on the system to the extent that they do not want to return to conventional drawing.

For inputting existing illustrations, Boeing ordered a scanner from Broomall in Pennsylvania. The scanner scans existing art and converts the resulting digital data to a lineal display that can be manipulated by the Applicon system for revising the art. This scanner had not yet been received as of October 1976.

Illustrations are stored in a random-access magnetic-tape system designed for 200,000 illustrations on high-density tape. The system uses an IBM 370 computer. Final output of merged text and illustrations is on an Information International COMp80 photocomposer.

The existing system is impressive, and Boeing operates it on two shifts. The initial cost is equally impressive, and is estimated at about $2.5 million. The equipment produces a new illustration in one-half the hours needed to produce it conventionally, and Boeing expects revised illustrations to cost one-quarter the hours required conventionally. As a result, Boeing says that the system will produce more uniform and better quality illustrations faster and at a lower cost than manually. Boeing believes with their volume of customized manuals that the system will be cost-effective. Some of the future plans for the system are shown in figure 4-13.

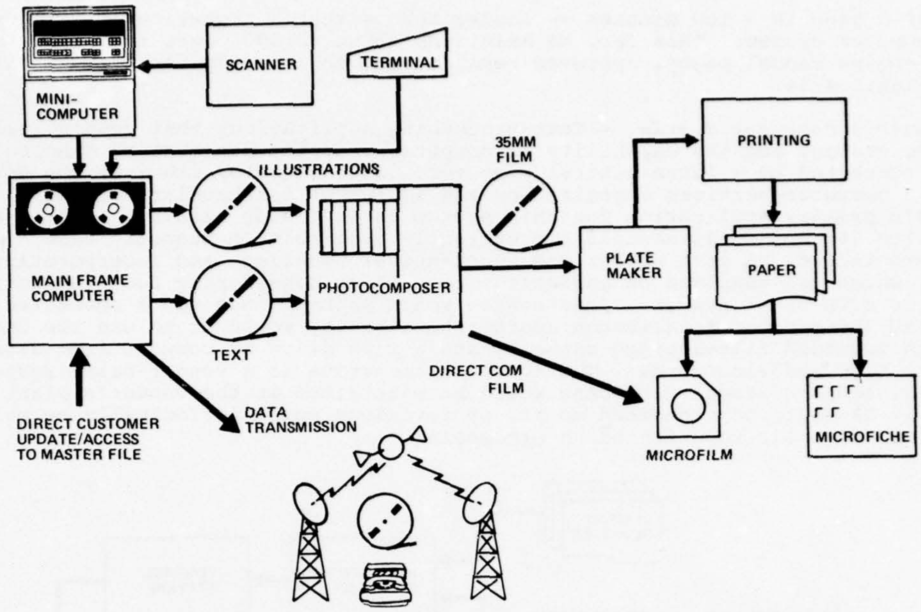


Figure 4-13. Boeing APS I and APS II Integration (Third Stage)

4.3.3 *United Airlines (UA)*

This description of United Airlines (UA) is based on a paper entitled "Automation of the Small-Scale Technical Publishing System," presented by Guy Shortz, Jr. and John M. Parker of UA (9) at the AIA and ATA Joint Symposium *on Automated Publications at Scottsdale*, Arizona on 20 May 1976. Like JPL, part of UA's system is based on a Daconics terminal. However, UA's microfilming requirements have led them to a much higher degree of sophistication, and for other applications they use a large-scale central computer. This ability to mix elements of different approaches for varying applications is typical of the increasingly pragmatic approaches being taken toward automation.

Although catalogs and manuals have been customized for more than 20 years at UA, the economic conditions of recent years are motivating UA, like most others, to find more economical ways to produce these customized publications. According to UA, making greater use of computer-assisted processes seemed to be the way to go. Until 2 years ago, most systems that UA was aware of attempted to solve all publishing problems with a large, expensive central computer system. The volume of work at UA could not justify a large-scale system, so a study was undertaken to analyze the entire spectrum of publications to see what could be done. UA reported finding that publications could logically be divided into three categories:

1) *Miscellaneous Documents.* - One-Time documents with very low revision rates.

2) *Secondary Publications.* - UA-originated engine manual revisions and general maintenance manuals; medium-to-high revision rate; no need to interface with other files; and, most important, on-demand publications that require fast throughput.

3) *Primary Publications.* - Major maintenance manuals and catalogs; published on 16-mm roll film and microfiche; very large file size; low-to-medium revision rate; publication intervals of several weeks or months; strong need to interface with other files.

UA looked at the various processing systems available and matched these categories to the systems.

Types of Systems. - Text processing at UA includes the following types of systems:

1) *Electric Typewriters.* - Until fairly recently, manuals (but not catalogs) were maintained on typewriters, specifically, the IBM Executive typewriter with proportional spacing. UA reported that these typewriters will only be used in the future for a small part of the workload.

2) *Daconics System.* - The Daconics text processor was originally installed at UA on a rental basis, and was purchased in March of 1976. The system has two terminals, one processor, and one printer. UA refers to the Daconics system as a *text*-processing system because they plan on using it to maintain a file of about 35,000 pages, which is more than the usual number in *word*-processing applications. Since Daconics is a stand-alone system controlled by its own minicomputer, it enables retrieval, revision, and

printout of a page in a few minutes -- faster than either a typewriter or time-sharing central computer system. Thus far, UA maintains about 12,000 pages in the system, including engine manual pages, approved repairs, and engineering reports. The system is shown in figure 4-14.

3) *Central Computer System.* - Text-processing applications that need a large amount of off-line storage and the capability of computer updating can best be handled on terminals connected to a large central computer. Such a system requires the specialized skills of a computer-services organization and equipment for handling magnetic tape files. UA's primary application for this system is wide-body aircraft maintenance manuals. The 747 and DC-10 manuals are currently available on magnetic tape. Interface requirements include UA part number and stock-number updating, and incorporating vendor revisions, which are supplied on magnetic tape. UA is considering two alternatives. The first is a UA-based system. This system would probably use vdu's connected to the existing IBM 360 processor, although another possibility would be to use the Daconics system with expanded file-storage capacity and a tape drive to convert from disk files to magnetic tape and vice versa. The second alternative is a vendor-based system. The aircraft maintenance manual data base would be maintained at the vendor's plant. Remote terminals at UA would be connected to it, or revisions would periodically be mailed to the vendor on magnetic tape for batch processing.

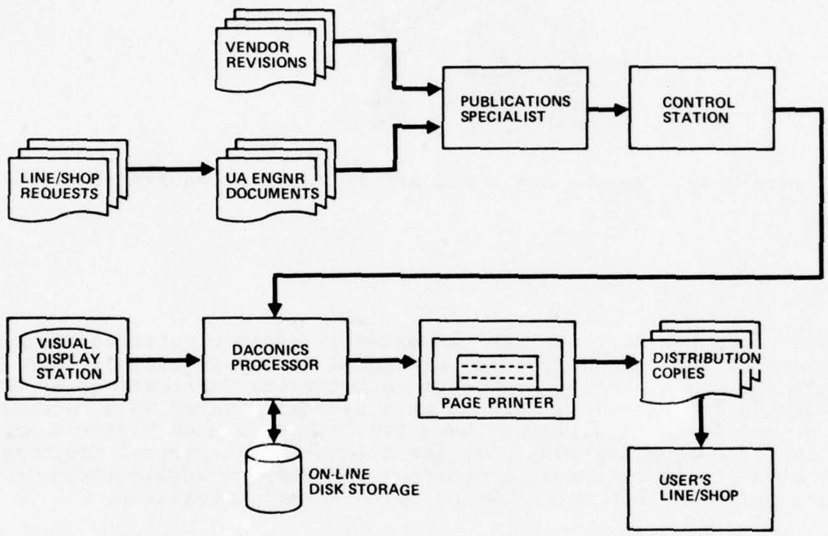


Figure 4-14. United Airlines: Processing of Secondary Publications

Output Devices. - Two new output devices will complete UA's automated publishing system for primary manuals and catalogs: the Datagraphix 4560 computer-output microfilm (com) unit and the Morgan microfilm optical merger (mom). Both are microfilm output devices, and both depend on a central computer for all or part of the input information. The Datagraphix 4560 is presently used to produce the stores catalog and master illustrated parts catalog index on microfiche. This is a straightforward process. The changes are run on the IBM 360 once a week to update the magnetic tape file. The tape is then fed to the com unit to produce a microfiche master, which is then duplicated for distribution.

Com equipment is extremely fast and efficient and produces high-quality microfilm. One of the primary objectives in UA's study was to use this highly efficient equipment for more publishing work, and thus reduce costs. But there was one obstacle: the com unit could not handle illustrations. Here is where optical merging enters the picture (see figure 4-15). R.A. Morgan Company of Palo Alto, California, is offering equipment that will automatically merge a reel of text on 16-mm microfilm with a reel of illustrations, also on 16-mm microfilm, in the proper sequence. An output reel of 16-mm microfilm will be produced, which will serve as the master film for duplication and distribution. The text reel is produced on the com unit, and controls the operation of the merging machine. Wherever an illustration should appear in the final film, the text reel has a frame open for it. In this frame, the com unit writes a bar-code to signal the merging machine to find the proper frame on the illustration reel and project it onto the output film. The machine then continues on through the text reel until it encounters the next place where an illustration is called for, and the process is repeated. The reel of illustrations is made up by manually photographing the art masters on an MRD2 planetary camera. An address bar-code is filmed with each page; it is this code that is read by the optical merger.

To make the system more efficient, UA plans to mount a third reel of microfilm on the merging machine, which will contain only the illustrations that have been added or revised since the last publication issue. The illustrations are also filmed manually on the planetary camera, but this reel makes it unnecessary to rephotograph any of the illustrations that are *not* new. When an illustration on the third reel is needed in

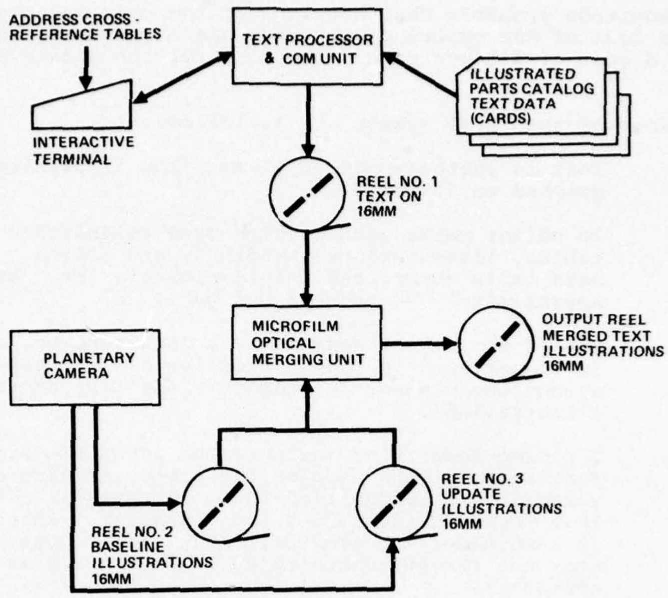


Figure 4-15. United Airlines: Optical Merging System

place of one on the second reel, the optical merger skips over Reel 2 and goes on to Reel 3. Of course, controlling this process requires making up a new text reel for every revision, but the new reel is produced on the Datagraphix com unit at a speed of 10,000 lines per minute. Also, there are many more changes to text than to graphics. The text is 63 percent of the pages in the file, but accounts for 86 percent of the revised pages. The optical merger is equipped with its own minicomputer to read the bar-codes and direct the optical system to the proper frame for the next exposure. Cycle time is 2 seconds per frame, which means the machine will do one year's work in about 360 hours of running time. An estimated 63 percent of the entire file of paper masters of the illustrated parts catalogs (or about 102,000 pages) can be eliminated. These masters are the parts list and index pages, which will be kept on magnetic tape.

4.3.4 *The TRUMP (Technical Review and Update of Manuals and Publications) System*

The following description of the U.S. Navy's TRUMP (Technical Review and Update of Manuals and Publications) System is based on internal Lockheed trip reports prepared by D.D. Perkins and H.G. Maxwell of the Lockheed-Georgia Company, Marietta, Georgia, and a TRUMP System description prepared by the U.S. Naval Air Systems Command, Washington, D.C., which was distributed at an industry briefing on the TRUMP System presented at the Naval Air Rework Facility (NARF), Jacksonville, Florida, on 25 December 1975 (10).

The U.S. Navy has many thousands of technical manuals to help maintain aircraft and related equipment. These manuals, consisting of some 1-million pages or more, require periodic update. While this is already a formidable publications task, it is expected to continue to grow year after year because aircraft and support equipment are much more complicated than they used to be. A trend to shorter production runs, longer in-service life, and the ever-increasing complexity of each new generation of aircraft has placed an early, continuing, and ever-expanding burden on the Navy for accurate and timely documentation.

The TRUMP system, installed at Jacksonville NARF, began as a study in early 1970. TRUMP is a total system for the automated production of technical publications. It converts existing documents from their printed form to a computerized form where they can be accessed and updated, and it automatically processes illustrations and complex tables as well as running text. By integrating the latest data entry, file maintenance, and photocomposition technology, the system is able to reduce both processing costs and elapsed time needed to generate publications.

TRUMP Schedule, Production, and Costs. - Before TRUMP, the Navy experienced 6 to 12 months turnaround time in purchasing update services from contractors. This span was measured from the procurement to the distribution of data to operators. TRUMP now provides update service in an average of 60 days. TRUMP also provides consistency of typography and layout techniques, which cannot easily be achieved from multiple contractors.

From December 1974 to September 1975, TRUMP performed the procedures for the input and storage of approximately 60,000 pages. From February 1975 to September 1975, the system produced 39,000 pages, which contained 5,000 updated pages.

The TRUMP management estimates a cost saving of about 62 percent in the editing and composition of manuals over previous conventional methods of purchase from contractors.

(A savings of this magnitude probably does not include the original cost of inputting the data, or prorated cost of the system development and hardware.) The input rate is 39 pages per hour at a cost of $13 per page. The cost for the update and output of a stored page is $6.

The principal operations of the TRUMP system are as follows:

Input Filming. - Text is photographed on 35-mm film; illustrations are photographed on 105-mm film.

Page Descriptors. - An editor marks each printed page to indicate blocks of text, tables, illustrations, headings, and folios. An operator at a data table enters the information via crt. Entry takes approximately 30 seconds per page.

Optical Scanning. - The 35-mm film is scanned by a densitometer, and each character is transferred to recognition logic. The page descriptor causes the scanner to scan only the text areas, skipping illustrations.

Recognition. - The page descriptor includes the identification of the type font used in each area on the page. As each character is scanned, the recognition logic compares it with an alphabet in that font and identifies the character. Those characters that it recognizes are stored in ASCII code. Characters that it does not recognize are rejected and stored as images of the characters.

Reject Correction. - An operator calls up the output file. As each rejected character appears, its image is flashed on a crt. The operator identifies the character and enters it through a keyboard. NARF says the rejection rate is currently running about 4 percent, and that it constitutes no constraint on the system. An average operator can identify and correct 400 rejections per hour.

Proofreading. - Proof copies are output on a line printer. Each page is proof read against the original material to ensure that format and content are correct, and that the ocr scanner has not made substitution errors (NARF says the substitution error rate runs around 0.2 percent). Tabular data is particularly difficult to proofread because it is printed out as a continuous unformatted column, in whatever sequence was used by the operator in defining blocks in the page descriptor. Coordinates are printed for each block to help the proofreader.

Corrections. - Terminal operators input corrections at the keyboard.

Automatic Indexes. - The program uses paragraph heads, illustration titles, and table titles to automatically create tables of contents, lists of tables, and lists of illustrations. It does not currently create alphabetical indexes.

Composition. - Magnetic tape is created for a COMp80 to produce text material. All cut and paste is eliminated. Rules for tables are created electronically. Text is composed on a crt and photographed. Illustrations are merged with the text at the proper locations, and a composite 16-mm microfilm of the complete manual is produced.

A technical manual contains pages of two types: those that contain illustrations, and those that contain only text and tables. The first step is to photograph all pages, for input to the scanner, on 35-mm microfilm. The next step is page format description. Illustrations and tables can appear anywhere. Because TRUMP has to meet minimum throughput speed requirements, this step serves as a primer to save time during scanning. The output of this step is a file, in page-number sequence, of parameters that specify the manner in which each page is to be read. When Grafix I finishes reading a page, it advances the film to the next page and reads the descriptor file for that page. This operation does not use human intervention. The scanning process creates and outputs files on disks. The file contains three kinds of data: 1) characters recognized properly, 2) characters recognized improperly (called substitution errors), and 3) characters not recognized at all.

TRUMP converts technical manuals from their existing typeset form into machine-readable language. It builds an intelligent data base, manages and modifies the data base and, when modifications are complete, recomposes output pages to produce a revised manual. Although TRUMP is primarily a *republication* system, the same techniques used for updating documents can be used for creating new manuals. A graphic overview of the TRUMP system (see figure 4-16) shows a technical manual, in printed form, entering the system at the top left.

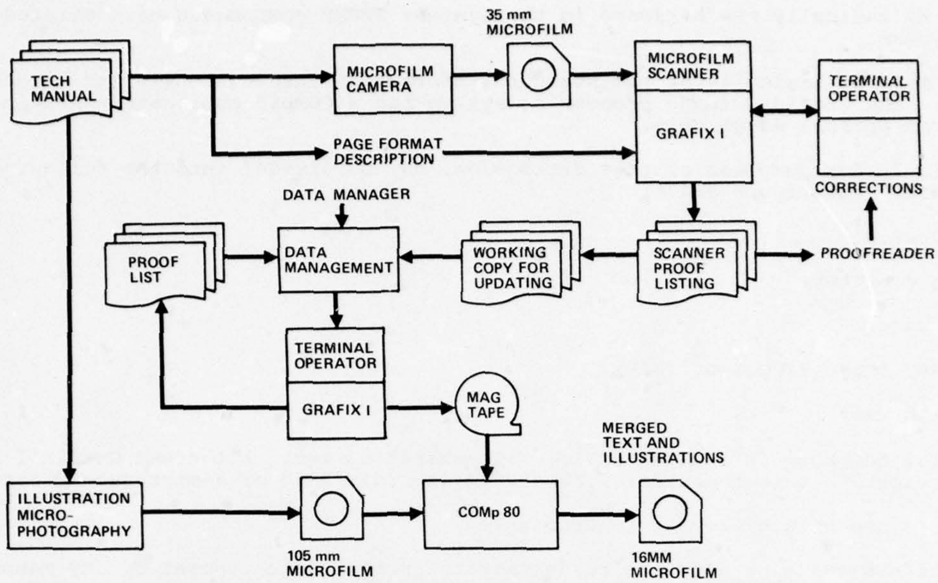


Figure 4-16. U.S. Navy TRUMP System

The input subsystem consists of the following activities:

. Microfilming.

. Page format description.

. Scanning.

. Reject processing.

. Index creation.

Microfilming, page format description, and reject processing involve people; the scanning task does not. Indexing is an automatic by-product of page format description and composition. Grafix I reads microfilm instead of paper. There are two reasons why this approach was taken:

. An original document can be any size and reduced during microfilming.

. There are none of the problems of paper jams and damage to original documents that exist with page readers. In addition, degraded images can be read on microfilm, which could not be read from paper (because transmitted light gives better contrast than reflected light).

All pages are photographed onto 35-mm roll microfilm. Pages containing illustrations are also shot on 105-mm film with surrounding text blanked off. Page format description is an interactive step to speed the process of reading pages whose formats are highly variable. This operation uses an edit terminal, data tablet, stylus, and function menu.

During scanning, Grafix I sequentially reads the descriptor file and microfilm images positioned in the film gate of the scanner. There is no operator interaction with the system to guide the scanner; that is the function of the page format descriptor file. The scanner contains a precision film-advance mechanism, a crt scanning mechanism (ocr and facsimile), and the control logic necessary to convert film images into a machine-readable form. The scanner is basically a high-precision densitometer, which measures the amount of light passed through the film at each point that it scans. It is capable of resolving an 8-1/2 x 11 inch page into approximately 1-million density points. Under software control, each line or field is identified and *intelligently* scanned. Text images are transferred character by character to the main recognition logic.

The scanning output is information of two types: characters that were recognized and characters that, for whatever reason, were not. The latter are called rejects. In reject conversion, the system presents a binary picture of the unknown character and the sentence containing the word in which it appears.

Text conversion is the technological breakthrough that makes the entire operation possible. The ocr process automatically converts printed text and tables into machine-readable codes at a high rate of speed, and with great accuracy. Standardized document formats mean that a single set of typographic specifications can be applied to the total population of manuals. Microfilm or microfiche can be produced on the COMp80 from the same data tape by changing cameras. Microfilm can produce printing plates using platemakers.

There is no radically new hardware in the system; TRUMP components have existed for several years.

TRUMP is made up basically of two standard Information International, Inc. products and software: the Grafix I image processing system and a COMp80 publication system, which includes an optical merge unit.

The Grafix I, for purposes of this discussion, may be divided into the following functional areas (see figure 4-17):

- Scanner.
- Main computer.
- Software.
- Binary Image Processor (BIP).
- Peripherals.

The central computer is a large-scale, time-shared system. All other Grafix I hardware is subservient to this computer. The system includes 256k of 1-microsecond core.

Software is one unique element in Grafix I:

- Multifont scanning software reads characters that were typeset by any manner other than hand printing. This includes embossing machines, typewriters, MT/ST composers, varitype, hot type, or photocomposition. It will read any typeface in any size, and learns new fonts automatically.
- Reject-conversion software provides the technique by which unrecognized characters are corrected. Reject conversion takes place after a file has been read by the scanner. In this way, nothing degrades speed during the ocr process.
- Conversion verification helps catch substitution errors.
- Time-sharing permits the simultaneous operation of ocr, reject conversion, conversion verification, updating, and output.
- Crt edit package provides the management of the data base. Commands allow an operator to add, change, delete, or move text. An extensive search capability can automatically find and change a specified text string.

Grafix I can be equipped with many combinations of peripherals; the NARF configuration includes the following:

- 192 core.
- Three drives.
- Five tapes.
- Two printers.
- Seven terminals.

The scanner is the second unique component in Grafix I. It converts microfilmed images to gray-scale pictures. The scanner has an addressability of 1-million points over an entire page image, and scans at speeds up to 1/2-million points per second. It steps up to 512 shades of gray but, by positioning, reads only 64 shades within the density range specified. It scans an area one line high and about seven characters wide at a time, passes the gray-scale image to the central computer, and reads the next segment of text.

The BIP is the heart of Grafix I. It is a unique computer developed for general-purpose image processing at very high speeds. The BIP performs the following:

- Converts the gray-scale image seen by the scanner into a binary picture.
- Breaks the binary picture into individual characters for recognition.
- Analyzes the quality of the character image and, if necessary, thins or fattens lines to develop the best picture to use during the recognition process.

During recognition, the BIP compares the unknown character image with a set of character masks that make up a font. It measures the correlation between the unknown and each mask, and passes the correlation values back to the central computer for final character determination.

The COMp80 is responsible for composition, typesetting, and illustration merge. The COMp80 can be divided into a tape i/o composition, imaging, and optical merge (see

figure 4-18). All standard tape formats (BCD, ASCII, extended ASCII, EBCDIC, or whatever), can be read by the COMp80. Character-code translation is done by software. The composition software, called COMpose, reads typographic commands and text data from the input tape, and sets fully justified multicolumn pages. COMpose also reserves space for illustrations to be projected onto the microfilm output. It selects an illustration, projects it onto the film, and sets text around it. The imaging subsystem consists of a crt and a camera for recording crt images and images projected by the optical merge unit. Cameras are interchangeable by the operator, and output can be any standard microform, although TRUMP is currently only using 16-mm film output. The optical merge unit consists of a film transport, which carries 105-mm roll film containing images of illustrations; a light source, which projects the image, via a mirror, onto the output film; optics; and a logic unit, which reads codes identifying the illustrations. Under program control, the optical merge unit retrieves the required illustration, checks its identification, flashes it onto the output film, and sets type around it (changes in the illustration file are handled by cutting out the old image and splicing the new one into place).

The overall operation may be subdivided into three functional groupings: input, update, and output. Because TRUMP is a time-sharing system, the three functions are performed simultaneously, although usually on separate documents. In fact, multiple documents can be both updated and output while the scanning process is underway on another document.

Once the manual has been stored in memory, it can be changed by keying in new material during editing. Suffix-lettered change pages can be created, or the entire manual can be recomposed as a revision.

MIARS (Maintenance Information Automated Retrieval System). - The final products of the TRUMP system are cartridges of 16-mm microfilm to be used in the Navy MIARS. MIARS is a system for the total use of 16-mm microfilm at all three levels of maintenance (organizational, intermediate, and depot). Each cartridge contains 2,000 microfilm frames, and usually consists of three to six manuals.

The microfilm cartridges are used in an AR-150 stationary reader-printer or a portable reader, which can be used at the aircraft or work bench. The units have a pushbutton retrieval system. Microfilm frame numbers are used as manual page numbers. The first frame of each cartridge is an index by frame number for each manual. Within each manual, the indexing is done by using frame numbers in the table of contents, list of illustrations, and list of tables. Alphabetical indexes are not prepared, and are not used in any manuals. As of 1975, the MIARS system had approximately 800 microfilm cartridges covering 10,000 manuals.

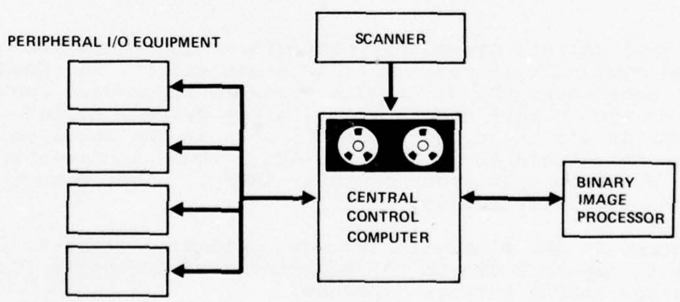


Figure 4-17. Grafix I Image Processing System

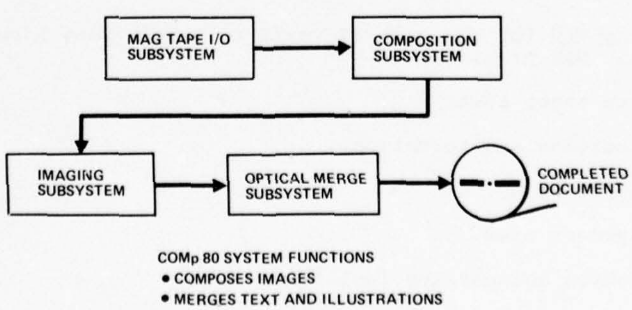


Figure 4-18. COMp80 Publication System

4.4 REMOTE TIME-SHARING SYSTEMS

In this section we will look at some systems that are designed to extend the power of the computer by providing it to users at remote locations via telephone lines. In a sense, some of the systems we have already examined are time shared. Minicomputer shared-logic systems are based on the ability of a computer to use part of its memory for one function, while other parts are doing something else. Large-scale computer-based systems, such as Lockheed's Autotext, described in paragraph 4.3.1, often serve users located at many remote locations throughout the facility. Moreover, the central computer is used for purposes other than text processing and, hence, the publication function is *time-sharing* the computer with other applications going on at the same time. This section, however, is devoted to those systems designed primarily to bring high-powered computer publishing technology to remote users whose volume may be relatively small -- too small for a dedicated system -- but whose applications seem to warrant a high-technology approach. The capabilities of such systems are not unique, and we will therefore be dealing in this section primarily with applications.

4.4.1 *Stanford Research Institute's (SRI's) On-Line System (NLS)*

The paragraphs that follow provide a description of the system of computer aids (NLS) that the Augmentation Research Center (ARC) of Stanford Research Institute (SRI) has developed and is making available for use by customers (11). This information is derived from conversations with David Potter of SRI's Princeton, New Jersey office; a visit with Robert Lieberman and Dirk Van Nouhuys at ARC in Menlo Park, California; and a visit with Duane Stone at the U.S. Air Force's Rome Air Development Center (RADC), an NLS user.

NLS is a very large system of (mostly) interactive computer aids. It is designed to allow individuals of an organization to use the computer tools to carry on their necessary work; its design also includes features that will capitalize upon cooperative working connections with other computer tools. NLS has been evolving and has been used during the past 14 years. It has a rich set of capabilities for handling structured text, and over the past two years it has gained a basic capability for handling graphic constructs integrated into the associated text. In 1973, ARC established a utility service to which any organization can subscribe. Subscribers pay a flat rate for a share of computing power and information storage, along with support service including training, application consulting, documentation, programming support, and operator services. More than 15 large organizations currently subscribe to this service. The reasons for establishing this service, according to Mr. Lieberman, were twofold: first, to have a larger base to evolve from in which to obtain criticism, etc., from nonprogrammers and nonscientists; and second, to transfer ARC's technology to the outside world.

At ARC, there is an applications group that consists of documentation services, applications services, and systems services. Mr. Lieberman and Mr. Van Nouhuys, of applications services, help coordinate the NLS applications to accomodate each particular subscriber's needs. From each client organization, a key person, called an Architect, designs the use of NLS in his or her environment, acts as the focal point of information, and is the liasion between the client and ARC. These architects form a group called the Knowledge Workshop Architect Community (KWAC). They communicate with each other through NLS and meet periodically.

There are five computers in ARC's utility service, called: Office-1, ISIC, ISID, NSA, and SRI-KL. All these computers are in the Department of Defense's (DoD) Advanced Research Projects Agency (ARPA) network (ARPAnet).

The NLS system has numerous subsystems available. Many of these are presently being used and others are still in the experimental stage. The most commonly used subsystems are: 1) BASE, 2) SENDMAIL, 3) PROGRAMS, 4) USEROPTIONS, 5) MODIFY, and 6) GRAPHICS.

ARC has been developing NLS for the past 13 years to supply many kinds of aids in a range of environments. NLS provides:

- Variety of ways to enter text.
- Highly flexible editing and formatting.
- Many kinds of output media.
- Publication management aids.
- On-line communication and catalog facilities.
- Connection to other computer systems.
- Data base management aids.

NLS is available as a computer utility service from various hosts affiliated with the computer network originally sponsored by DoD's ARPA, and on a commercial service bureau. NLS is also available as a software package for use on an in-house computer.

ARC is both the creator and most extensive single user of NLS. It is a large and sophisticated system, and is aimed at providing a consistent and comprehensive environment for knowledge work, of which document production and control is only one instance. ARC produces a large number of documents. Documents are produced for proposal writing, reports for projects performed within ARC, NLS system documentation, and a very large number of user guides. Most documents are relatively short (20 to 70 pages), and the control mechanism is usually very simple.

The number of authors of a document varies from one to as many as five or more. Writing is usually done simultaneously; each author is responsible for one logical unit (i.e., chapter) of the document, and all have access to each other's text. Authors do most of the editing and page formatting themselves. Only at the very final stages of document production (if at all) is a professional editor introduced to take care of final touches.

Bibliographic searches and researching are done by authors on-line. The Journal (described below) provides the mechanism for on-line searching of any previously created documents. In addition, authors have personal on-line data bases in which they keep notes and results in an informal way (much like a notebook), and they use this data in the document-writing process.

Physical Attributes. - NLS runs on Digital Equipment Corporation (DEC) large-scale computers in the PDP-10 or PDP-20 classes. Access to the computer is achieved via telephone lines or through the ARPAnet (for certain government agencies and contractors). It runs in a time-sharing environment under the BBN TENEX or DEC TOPS20 operating systems. The system is over ten years old, is constantly improved and upgraded, and provides a stable working environment.

The present Office-1 computer configuration uses a 512k memory PDP-10 with 76,000 disk pages (a disk page is roughly equivalent to one typewritten page). Many other configurations can satisfactorily support about 20 users; when the system becomes more heavily loaded, users often complain of the slow response and indicate a considerable reduction in their productivity.

NLS can be operated from two types of full-duplex work stations: hard-copy typewriter-type terminals and display terminals. A basic alphanumeric display work station consists of a crt display and a keyboard; additional equipment that is part of the work station is a pointing device (called a *mouse*) and a *keyset*, which facilitates text editing. A second display, which allows line drawings, may be added to the work station. A user with a teletype terminal may use a version of the system homogeneous in command language and functions with the display version.

Software Environment. - NLS is divided into function-oriented packages called subsystems. In the context of document production, NLS includes subsystems to edit text using structured files, and a formatter that accepts directives for formatting a document for a line printer, terminal, and/or phototypesetter. A graphics subsystem allows on-line creating and editing of line drawings, which can be incorporated into a file to produce mixed text and graphics when output to a phototypesetter. A proofreading subsystem enables the operator to check the page layout of documents that will be phototypeset. There is also a spelling correction program and a variety of other tools to aid document production.

The user interface is a command language consistently structured across all subsystems. As part of this consistent interface, each user can define a profile that includes a variety of parameters to control the appearance of the system to that user. This profile includes choices of command-word recognition modes, page-margin settings, the amount of prompting the system should give, etc. The profile can be modified, and enables the more advanced user to use the system more efficiently while giving more explanatory material to the beginner.

A key feature in the design of NLS is its hierarchically structured file system. This feature allows a user to view various outlines of a document, and allows the page formatter to compose the page according to paragraph level.

Input. - Text can be entered into NLS directly at teletype or display terminals, from magnetic media created at off-line terminals, or through copying on-line files from other computer systems or devices such as ocr's.

Deferred Execution (DEX) is a complement to NLS for inserting text with minimal editing in an off-line mode. The user records typewritten text and a set of special instructions on a magnetic tape cassette. During periods of low usage on the computer, the tape is read to produce an NLS file.

NLS enables the transfer of files from one computer attached to the network to another by a single command. An operator may request to *load* a file currently residing in a foreign site, and will have the file loaded on the screen as soon as transfer is completed (subject, of course, to access rights).

The most common way to input text at ARC is through the display or typewriter work station. The display work station consists of a display and keyboard, a pointing device called a mouse, and a five-finger keyboard called a keyset. The input devices are connected to the terminal computer through a line processor.

The mouse is a hand-sized pointing device that rolls freely on any flat surface, moving the cursor on the display screen correspondingly. The keyset is a device with five piano-like keys for entering characters (and commands) at the display console. With the left hand on the keyset and the right hand on the mouse, the user can give all inputs to NLS without ever moving either hand to the keyboard, keeping the eyes on the screen while quickly specifying commands. Many experienced users move both hands to the keyboard only for typing in long text.

Line drawings may be input to NLS text files and edited from a work station equipped with a graphics display.

Output. - NLS can easily be interfaced to a wide variety of commercially available output devices. Terminals, magnetic tapes, files on disks, and cassettes are examples of currently supported devices. A direct interface to a phototypesetter could be made with minimal effort. For most work, ARC users rely on their terminals (typewriter or display) and a line or Diablo printer for output. Short documents and messages are usually read at the display or teletype terminal, whereas longer documents are printed on a high-speed line printer that may be housed at ARC, the utility or, in special cases, the user's site.

For typewriter quality output, Qume or Diablo terminals are used. For photocomposition of text using a variety of fonts, documents are formatted and output to a magnetic tape. Currently, the ability to process these virtual photocomposer tape files has been implemented on a Singer 6000 and an Information International, Inc. COMp80. In addition, the Singer 6000 allows the mixture of text and line drawings.

Distribution. - Distribution mechanisms for documents vary depending on the recipients of the documents. Distribution of documents outside ARC and their user community (e.g., proposals and reports to government agencies) is done in the conventional way of mailing hard-copy versions of the documents.

Within ARC and their user community, distribution is done via the ARC Journal supported by NLS. A document (or any part thereof) may be journalized and sent to any group of individuals. The content of the item is kept (forever) in a central location, and the individuals on the distribution list are notified of the item's existence along with a path name enabling them to read it on-line or copy it to any of the available output devices.

ARC Journal items are *frozen* and may not be modified; thus, a new version of a document is handled as a completely independent new item. The ARC Journal records the date and time it is submitted, the author, the distribution list, and other relevant information. It also catalogs all items according to date, author, title, and keyword. The catalog is available on-line and enables on-line searching of the entire ARC Journal. The author of a document may specify that only a selected group of individuals may gain access to the content of an item, and such private items are not catalogued.

The ARC Journal was originally designed and implemented for a single computer site. It has since been extended to receive and deliver communications for two composer sites. ARC reports that the implementation is clumsy and should be generalized for multiple sites for better efficiency.

Communication. - Communication between NLS users is mostly done through the Journal. In addition to using the Journal as a means for document distribution, NLS users may send short messages to each other. These items are recorded as usual, and serve as an activity log on a specific project or document.

ARC uses the ARPAnet for its activities and uses a message-sending mechanism (SNDMSG) provided by the hosts on the network. This facility is used when communicating with non-NLS users, and occasionally among NLS users when it is not necessary to record the message.

A unique screen-sharing facility is provided by NLS, which enables two display users to work concurrently on the same file. Both users have the same text displayed on their screens. Any modification to the text or viewing done by one user concurrently updates the other user's screen. This feature is used when two or more authors have to work in close cooperation and time and the geographical distance do not permit face-to-face communication.

4.4.2 *Application of NLS at Rome Air Development Center (RADC)*

The Information Sciences (IS) division at RADC is responsible for conducting exploratory research and advanced development in all aspects of computer science applicable to Command and Control systems. Emphasis is placed on research and development to reduce the cost and improve the quality of software, on parallel processing computer architectures, and on computer networks. NLS has been in use within IS for 5 years, the last 4 years via the ARPAnet. Initially, it was used by a few in an exploratory, evaluative mode, to assess its capabilities and possible application to Air Force problems. With the advent of the Utility Service in January 1974, it has been increasingly used to support the mission of the IS division.

The use of NLS within IS has been voluntary in the past. Only recently has some use become mandatory. The increase in use has been gradual, expanding in both depth and

scope from individual use to working group use and is now entering the organizational use phase. The style of use varies from one where all input and output is via a secretary to one where on-line composition is the norm. Approximately 30 of the 90 people in the IS division currently use NLS. The usage ranges from simple sending and reading of messages to accomplishing almost every aspect of daily work.

Communications. - The SENDMAIL subsystem transmits messages and documents to those that have access to NLS and the Journal, both internally to RADC and externally to contractors. In some cases, it is used in place of hard copy to transmit guidance to contractors. The Journal is also used as a "filing cabinet" to record, index, and store drafts, background "thinkpieces," and backup copies of documents and data bases.

The MESSAGE subsystem is the NLS interface to the ARPAnet standard mail system. It transmits "quick and dirty" messages to sites on the ARPAnet that do not have access to NLS, or in cases where it is not important to have the message recorded and indexed.

Correspondence. - The mission of IS is carried out primarily through contracts with private industry. The business of formulating and monitoring a contract within the framework of detailed regulations requires numerous pieces of internal correspondence between the engineer and the contracting officer. These include memos, letters, statements of work, trip reports, etc., accompanied by innumerable forms. For those that use NLS on a regular basis, it is a great aid in the composition, editing, formatting, and filing of correspondence.

The following is a typical *scenario:* the body of a piece of correspondence is prepared on-line, perhaps using parts of existing files. It is run past the SPELL program to correct typographical and spelling errors. It is then formatted by a special RADC FORMATTER subsystem that prompts the user for routing, subject, attachments, etc. Depending on the type of correspondence, it is then printed on letterhead paper by a high-quality serial printer or on a line printer, signed, and placed in the internal mail system.

Those who use the system in this manner do not view their role as one of a typist, since they can compose as they go along. It is often possible to make use of portions of other similar memos, which lessens the typing job. They can immediately see what they have written, and revise until it is satisfactory. There is no problem with finding and pushing a typist, no queue, no typist-induced errors. A two-page memo to procurement typically takes 1/2-hour to compose, edit, print, sign, and drop in the interoffice mail system. The only manpower savings may be secretarial (especially if retypes are required), but there is a definite savings in real-time.

Files. - NLS is used, in place of a filing cabinet, to store all on-line correspondence generated or received by users that is pertinent to a contract. A record of an effort from the planning stage through completion is then available for immediate recall. These files are much easier to organize and search than the equivalent paper files, and are often consulted to answer questions during the course of a phone call.

Programming. - The PROGRAMS subsystem is used by advanced NLS users to quickly write programs that perform repetitive editing across many statements in a file, provide special filtered views of a file, or give sorts on strings embedded in statements. Since the command language of PROGRAMS is consistent with the editing command language and the interface between the source code file and the compiler is direct, it is possible to write, compile, load, execute, debug, and repeat this cycle several times within a single session, making programming by the nonprogrammer a possibility.

Two higher level languages are available via the PROGRAMS system (CML for specifying the interaction with the user and L-10 for specifying the executable routines). Since source-code files are simply NLS files, one can copy and modify other codes that are similar in function. Since all subsystems in NLS itself are written in CML and L-10 and since the languages are procedure-call in nature, it is often possible to simply call one of several thousand procedures to accomplish part of a job. PROGRAMS has been used at RADC to create two additional subsystems tailored to RADC problems. One is FORMATTER, a subsystem that prompts the user for inputs and inserts the user's responses and output processor directives in a file to allow printing according to the specified format for RADC correspondence. FORMATTER aids in preparing six different kinds of correspondence and two kinds of forms. The second subsystem supports the management of IS dollar resources. It is much more complex and is discussed under management below.

Management. - Components of the BASE, MESSAGE, and PROGRAMS subsystems have been used, along with external procedures, to create a suspense notification capability. Actions, their due-dates, and the responsible organization are inserted in a file in a standard format by IS clerical personnel. Once the action has been completed, they are cleared from the file. Actions that recur on a weekly, monthly, quarterly, or yearly basis are left in the file. Periodically, a "canned" set of NLS commands is executed to automatically sort, group, address, and insert items into the mail system for on-line delivery to subordinate offices in the chain of command. This capability helps upper management meet suspense dates by notifying action offices on a regular basis, with sufficient enough lead time so these dates can be met.

At any instant in time IS has over a hundred contracts, involving several million dollars, in various stages of procurement. It is almost impossible to track their progress, let alone answer the question "Can I afford to start another effort at

this time?" To assist in this problem, IS has developed a Financial Management System (FMS). Very briefly, FMS consists of a data entry module, a master data base consisting of one or more NLS files, and a query module.

The master data base can only be changed via the data entry module, which has access limited to a few qualified administrators. A ledger file is maintained, which records all changes to the master data base to provide backup and traceability.

The query module allows the copying, viewing, or printing of a subset of the master data base. Subsets can be obtained by specifying a major structural component of the data base or by searching for values in any single (or combinations of several) field. Special views are obtained directly by commands built into the system or by filtering through a user-created template. This allows a user to create his or her own report format, without the intervention of a programmer.

FMS has proven to be a real aid to IS division-, branch-, and section-level management. Plans are underway to expand it to a Resource Management System, where manpower and other important IS resources will be included. An interface to the GRAPHICS subsystem is also planned so that bar charts, trend diagrams, and pie charts can automatically be created.

4.4.3 *ADPREPS and Wordwright*

ADPREPS. - To learn more about ADPREPS, LEC visited William Campbell and Richard Ludwig at the U.S. Naval Ships Weapon Systems Engineering Station (NSWSES), Port Hueneme, California.

ADPREPS, the time-shared system developed at NSWSES, comprises seven Control Data Corporation (CDC) terminals, a UNIVAC 9300 high-speed printer and batch transmission interface device, a UNIVAC 1108 computer, and an APS-4 photocomposer. The terminals, which consist of a crt display screen, cassette recorder, and thermal printer are housed in the NSWSES Production Center, along with the APS-4 Photocomposer. The UNIVAC 9300 is housed in the NSWSES Telecommunications Center and the UNIVAC 1108 is housed in a computer center about 80 miles from the base (see figure 4-19).

ADPREPS is both an on-line and off-line system. Three terminals are dedicated on-line terminals; at these work stations, operators key-in text directly to the UNIVAC 1108 computer across telephone lines. Two terminals are dedicated off-line terminals; here, operators type onto tape sent to the computer center. These tapes are processed through the UNIVAC 9300 and new tapes are obtained. The tapes are then processed through the APS-4 to obtain camera-ready copy. Nine-track tapes are used as an intermediary step so that material is not lost when sent over telephone wires.

The majority of NSWSES documents are U.S. Navy technical manuals and, hence, are guided by Navy specifications. Therefore, the applications and programs used with the ADPREPS system are also based on Navy specifications. Mr. Ludwig explained that NSWSES computer personnel have modified programs that are used in the system to meet their own needs, such as the UNADS program, which was originally a UNIVAC program.

Printouts of text can be obtained during the day it is input, but NSWSES personnel believe this is a slow turnaround cycle. NSWSES personnel also reported that their writers feel that the system takes away from the author's individuality. The reported output of the system, about 500 pages a month, seems low for a system of this capacity. It would seem probable that as system use expands, its efficiency and acceptance by technical authors will also grow.

Wordwright. - Although this study is primarily based on examples from the United States, the British Wordwright system is worthy of mention because it represents the results of the transfer of technology across national boundaries, and from the military to the civil sector, of which we can expect to see more and more. The ADPREPS system described above was originally designed by Comarco, Inc., Oxnard, California, for NSWSES, although ADPREPS currently is entirely under U.S. Navy operation and management. Wordwright is the result of a joint venture between the British Printing Corporation and Comarco, and the system is partially an outgrowth of the original ADPREPS system. The Wordwright system is now being marketed in the United Kingdom both as a remote time-shared service bureau (such as that described in paragraph 4.4.4), and as an in-house system for larger organizations. It is the first time-sharing service in the United Kingdom to offer a specially designed vdu and a daisy wheel printer as standard terminals.

4.4.4 *The Service Bureau Approach*

The kind of large-scale computer power described in some of the previous systems can be made available to relatively small users by means of service bureaus that offer text processing services via telephone lines. The two largest in the U.S. are Proprietary Computer Systems (PCS) in California and Bowne Time Sharing in New York.

PCS is a California-based computer service bureau that offers a wide range of computer services to remote users over telephone lines. The services include the following:

- Remote job entry to batch processes.
- Information retrieval and data management.

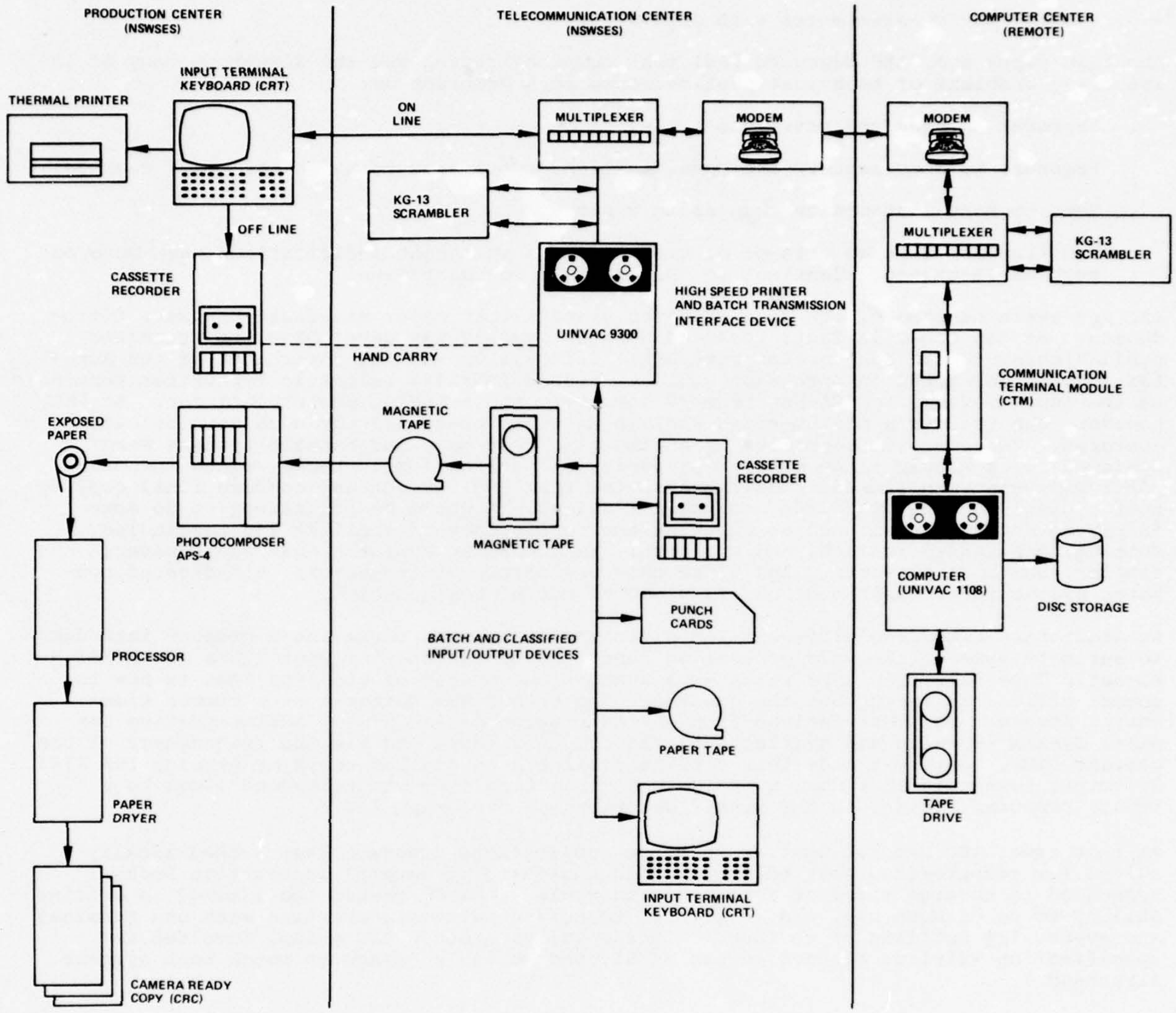


Figure 4-19. ADPREPS System Flow

- Interactive text editing.
- Document formatting and output to a tape for a com device.

In addition, PCS has developed a set of special application packages tailored for text processing in law firms, financial management systems, a PERT project management system, etc. PCS also offers interactive user programming in APL. The system runs on two IBM 360/65 computers. The text editor is a version of IBM's ATMS that has been enhanced by PCS. In general, PCS document production service is very similar to that offered by Bowne Time Sharing in New York.

Bowne offers a sophisticated text editing and management system called Word/One. It operates off an IBM 370/155 computer system located in New York City, and services over 350 subscribers in the New York, Boston, Philadelphia, Washington, Atlanta, Chicago, Houston, Los Angeles, and San Francisco areas. A variety of i/o devices are available to interface with the system, and Bowne can provide both high-speed printer and photocomposition outputs to its subscribers.

4.5 BATCH PROCESSING AT LOCKHEED ELECTRONICS COMPANY (LEC) -- A CASE HISTORY

This case history of an actual publications program at Lockheed Electronics Company (LEC) is included not as a recommendation of one particular technique over another, but as a detailed example of how modern technology of varying types was applied to a relatively small publications operation. Moreover, the decision-making process by which LEC selected an optimum approach for a particular program may help others who are first automating their technical publications although, obviously, the cost factors and available technology are much different today than several years ago, when this program began. The intent of this section is to emphasize one of the underlying themes of this report: that there is no *right* or *wrong* or *best* approach to the automation of technical documentation; there is only an *optimum approach* for a *particular user* with a *specific problem* at a *distinct point* in technological development.

4.5.1 *LEC's Early Experiences with Automation*

About 10 years ago, LEC began to feel that computerization was the answer to many of the recurring problems of technical publications, such problems as:

- Frequent changes and revisions.
- Pressure to keep manuals and specifications up-to-date to match equipment changes.
- Need to make last-minute changes in a hurry.
- Publication of large sets of documentation on equipment modifications that were as much as 75-percent identical to the original documentation.

LEC was aware of some of the sophisticated systems that major manufacturers were introducing. At the time, in fact, Lockheed-Georgia Company was developing its automated publishing system in conjunction with RCA. This system was the forerunner of the Autotext system described in paragraph 4.3.1. It used IBM 2741 Selectric typewriter terminals as the input medium, an RCA Spectrum 70 computer, and a Photon phototypesetter. At LEC, however, our role as a medium-sized publishing group precluded any such sophisticated ventures. Moreover, it seemed to us at the time that many large-scale systems were designed for a single large program or family of publications. Hence, since the computer was being programmed to edit and revise text and lay out and compose final copy to meet a single set of standards and specifications, it could be programmed to do some fairly advanced things, such as checking the consistency of spelling and terminology, setting up standard formats, and so forth. We needed an approach that was cheaper, simpler, and more flexible. And since this was before minicomputers, a dedicated computer system for a department our size seemed out of the question.

At about that time, two different IBM divisions each began marketing a product intended to automate some of the word processing functions of the smaller user. One was MT/ST -- Magnetic Tape Selectric Typewriter -- a stand-alone system of the type that is now in common office use throughout the country. The second was Datatext -- a remote time-shared system. Datatext derived from an IBM program called ATS -- Administrative Terminal System -- which was available to IBM computer users and was the predecessor of the current ATMS. Datatext made this service available to smaller users by placing IBM 2741 Selectric terminals in a user's office and connecting them via telephone lines to a remote computer center, in the manner described in paragraph 4.4.

At this time, LEC had two smaller in-house publications programs that looked ideally suited for computerized text editing. Both consisted of several instruction books scheduled to undergo three or four revision cycles. MT/ST seemed too limited in editing ability to be of much use, and we elected to put in Datatext, starting with one terminal and eventually building up to four. (Incidentally, another LEC group, involved in specification writing, elected to use MT/ST, and we had a chance to watch both systems firsthand.)

Datatext worked fairly well, and although IBM no longer markets this system, the same basic approach, with many added refinements, is still being used successfully by other data processing firms, as described in paragraph 4.4. The system worked well, that is, as far as performing its functions. There were other problems, however, attendant to our type of usage.

First, when an operator typed over a telephone line for 8 hours a day, the operator was, in effect, making an 8-hour long-distance call. With four such terminals, the telephone bills got rather high, even when leased lines were being used.

Second, when the workload went down temporarily, the user was still paying the fixed costs of the terminals and the basic service charges.

Third, when the workload was subject to dramatic peaks, as often happens in the aerospace industry, the user was still limited to entering data on the terminals that had been leased. Even if the user could lease additional terminals and telephone lines in a hurry, it was still difficult to obtain trained people to operate the terminals. Some systems today have overcome this problem to an extent by also accepting material in a batch-processing mode.

Fourth, the system of mailing back the computer output copy to the user often proved too slow for applications that depended on fast turnaround times.

Fifth, the complex billing system, which depended on such varied factors as hours of usage, amount of data entered, amount of data corrected, and amount of data stored at the peak storage period, made it difficult to estimate and track the costs of specific tasks.

Sixth, there was at that time no phototypesetting option available with the system, and the quality of the high-speed printer output was often too poor for some applications. Again, remote time-shared systems today offer better printouts, and most have phototypesetting options available.

The advantages of the system, however, were great enough to convince LEC that the computer had a real and vital role to play in technical publications. For example, one manual that we had to deliver consisted of several hundred pages of complex tabular material, and chain-printer output was acceptable to our customer as repro copy. Two operators entered the tables as they were developed over a period of a few months. During the last few weeks before delivery, the operators entered corrections and revisions as computer commands.

A few days before the delivery of the manuscript draft, the operators signaled the computer center to print out a repro quality draft. The next day we had a messenger pick it up. Several hundred complex tabular pages had been revised and printed out in a few weeks. It obviously would have taken a battery of operators to retype, proofread, and correct that much tabular material.

How did costs compare with a manual operation? Well, initial data entry costs were higher. Although the operator can, in theory, type faster when entering into a terminal, since there is no worry about formatting and there is no need to correct small errors immediately, in practice, it does not always work out that way. Operators still like to prepare a "clean" draft, and it is hard to untrain them. Moreover, the costs of terminal leasings, telephone expenses, and data storage and manipulation, all added to the bill. The big savings were in not having to retype and proofread the entire manuscript.

Was it worth it? Financially, no. LEC did not realize any significant cost advantages from this approach. However, for the particular project, meeting the deadline with up-to-date, accurate data was worth the expense. Obviously the system was effective, despite its limitations. But it was not yet cost-effective.

About that time, IBM decided to stop marketing the Datatext system, and we switched over to another time-sharing organization. And, for various reasons, our costs started to mount.

4.5.2 *The Mk 86 Publications Program*

LEC was, at that time, faced with the largest publications program in its history. The company was about to enter into production of the Mk 86 weapon control system: a large, complex, shipboard system that included two complete radars, a large-scale general-purpose computer, an optical sighting system, several digital processing units, and two display and control consoles. Moreover, the system was to be produced in four different configurations -- one prototype and three different production versions for three different types of ships. Each version would have its own set of manuals -- a 16-volume series. Some books would be the same in each version, some would differ slightly, and some would be considerably different. This seemed like an ideal program for a computerized approach. We could develop a data base for the prototype books and modify it three ways for the three production versions. But before we could decide to apply a computerized system to the Mk 86 program, there were some problems to solve.

First, and foremost, how would we enter the data? Obviously, there would be significant peaks and valleys in a typing workload of this size. Moreover, there would be other programs in-house competing for typing time. Some of these would have higher short-term priorities. In a conventional typing operation, the user simply contracts with outside typing services, or leases some extra typewriters and hires temporary help. But there are no available outside services that have computer terminals feeding into your system. Nor can you hire temporary operators that have been trained on your terminals. If you expand your staff, what do you do with your equipment and people during lulls? When LEC had four time-shared terminals, we had found there were times we needed eight terminals and other times when two or three were idle.

Second, there was the problem of output. These books had to be two-column high-quality repro copy, with illustrations intelligently and professionally laid out. We needed a more sophisticated system than the one we were then using.

Third, there was the matter of cost. We simply could not afford the terminal rentals, telephone costs, and computer storage charges that we would incur on a program of this size. Moreover, we had to be able to predict the costs for each operation, monitor the costs as they were increased, and assign them to the proper segment of the project.

Fourth, there was the problem of military security. Much of the Mk 86 material was classified and could not be handled over telephone lines.

We began looking at other time-sharing systems, but they offered no significant advantages. We even considered time sharing on our own company's large-scale general-purpose computer. At the time, however, there was no text-editing routine for that computer, and the time and cost involved in developing one were prohibitive.

We also looked at the minicomputer shared-logic systems then entering the market. These were new and not as sophisticated as they now are. They were limited in capacity -- about four terminals to a system. The problems of peaks and valleys in workload, then, applied to them as well. Moreover, they had no proven record of success, and we were concerned about service problems, stability of the manufacturers involved, and ability of the systems to perform.

4.5.3 *The Batch Processing Approach*

About this time, we also began looking at batch processed systems. In this approach, as stated previously, the data is recorded on some medium such as magnetic tape, paper tape, or punched cards. The data is then periodically entered into the computer during off-hours, when the computer is not busy doing something else. Moreover, the data is entered at the speed at which the computer reads it -- which is quite fast -- rather than at the speed at which an operator produces it.

The cost advantages of being off-line are obvious. The disadvantage of not having immediate access to our stored data seemed, at the time, equally obvious. It was clear that batch processing would only work if the computer subcontractor was close by and particularly sensitive to the needs of a military-oriented industrial publications department.

We continued to examine stand-alone, time-shared, and batch-processed systems until a combination of circumstances led us toward the New York branch of Volt Information Sciences. Volt was introducing a text-editing routine on its computer that it called Voltext and a photocomposition routine called Voltype (see figures 4-20 through 4-22). This combination offered us several advantages.

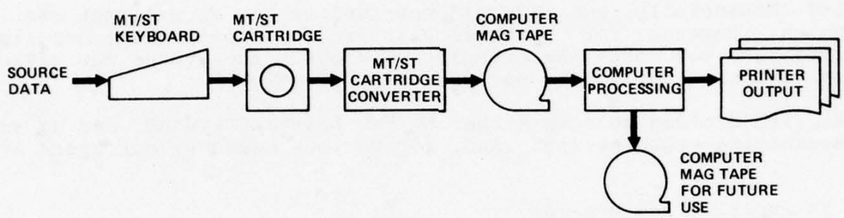


Figure 4-20. Text Entry Using MT/ST Equipment

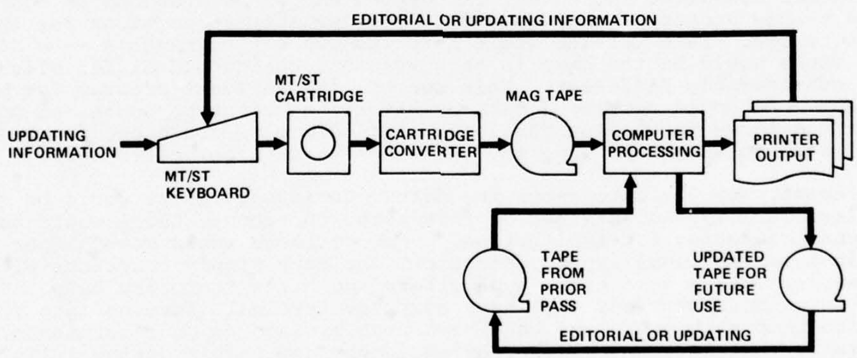


Figure 4-21. Voltext Updating Routine Using MT/ST Equipment

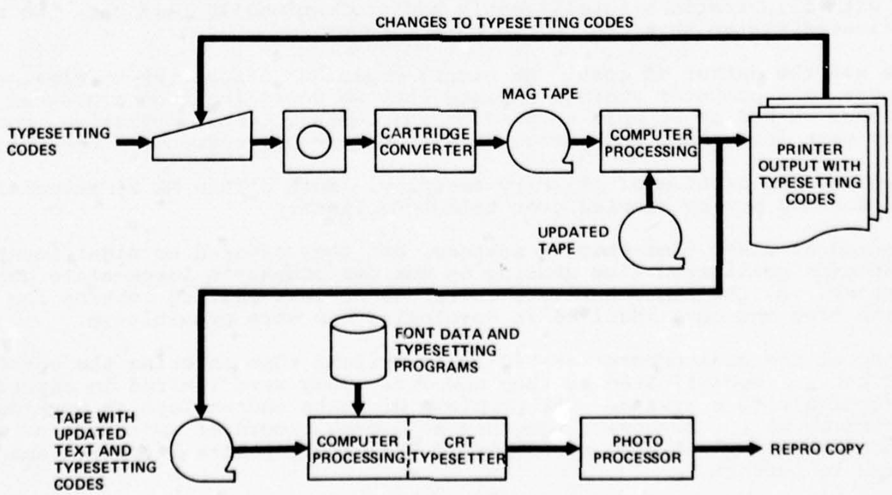


Figure 4-22. Voltype Phototypesetting Routine

First, it accepted MT/ST tapes as an input, by converting these tapes to computer tapes. At this time, our department had been given the responsibility for the company's MT/ST typing function in a move toward centralizing some of the company's technical documentation activities. This approach gave LEC the opportunity to use a single terminal in a dual capacity: MT/ST as a stand-alone device for shorter, fast-turnaround documents, and as a data-entry device for our technical manuals. As has been shown in other case studies in this report, when a new approach is an extension of equipment and technology already on hand, it is much easier to get management and employee support for it. Finally, outside back-up typing services for MT/ST were relatively easy to get.

Second, as a major supplier of many types of publications and graphics services in the New York metropolitan area, Volt, which was only 30 miles away from LEC, could offer daily messenger service when necessary.

Third, Volt had security clearance and was familiar with military specifications and formats.

Fourth, Volt had its own phototypesetting facility, making it possible to work with a single subcontractor for text editing, composition, and phototypesetting.

4.5.4 *Adapting to the System*

The main problem in adopting any computerized text editing system -- once the technical difficulties are solved -- is overcoming the natural resistance of people to change. Figure 4-23 is a flowchart of our text editing setup. Note that if we were to substitute some other type of terminal for MT/ST, this could serve, with minor changes, as a basic flowchart for any text editing system.

Now, where were the impedance points in this system? First, the writer. The writer was told to take the first pencil draft and enter it directly into the computer. The writer did not always want to do that, preferring to review a rough draft first. Sometimes this was the right approach, but before that decision could be intelligently made, the fact that it is usually advantageous to go directly into the computer had to be learned.

Of course, while the operator was creating magnetic tape, hard copy was also being produced, which was returned to the writer for reference. This added to the frustration. The writer had typed copy of the material and could see some errors. Why not correct the tapes now, using MT/ST, *before* the data went into the computer? Because, Volt insisted, it was cheaper and faster to correct the information *after* it was in the computer. But was it *always*? Of course not.

The writer also had to get used to working on single-spaced computer output, and making corrections alongside the line instead of in the spaces. In addition, the writer had to become accustomed to seeing tables not as they would appear on the final output, and to checking coded material during final review.

As for the editor, nothing was done the same way. The first editing pass was now made on the pencil draft, making sure that format, abbreviations, spelling, and other basics were all correct and consistent. Computer changes are only cost-effective up to a certain point, and if you are going to spend computer time correcting minor flaws, you reduce the system's effectiveness. The editor also had to learn to mark copy by creating

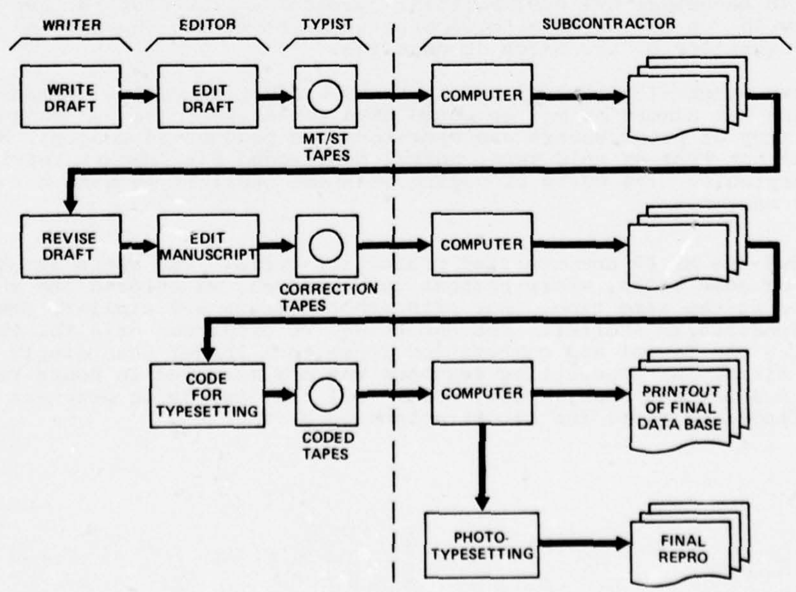


Figure 4-23. MK 86 Technical Manual Flow

a series of coded listings that told the computer how to correct the copy. (Some organizations have created a new specialty -- the *coder*. The editor marks up the copy and the coder converts the corrections to computer codes.) Before the final pass, the editor marked up the copy for phototypesetting -- again, using computer codes rather than the basic copy-marking symbols.

The operator, too, presented a problem. Traditionally, the operator had been taught that publications work must be letter perfect. Now the operator was being told to have two standards. For some kinds of work, as much care had to be taken as before. But for others, the purpose was to go as fast as possible, getting the data captured on tape for the computer. Minor errors could be corrected by back-spacing and retyping. Major errors could be overlooked, since the material was not proofread until the first computer run. For the operator, this was often frustrating. Hard copy was simultaneously being produced, and the desire was for the hard copy to be error-free. Often, the writers told the operator that they would appreciate it if their reference copy was "clean." So the operator erased, or otherwise made corrections, to make a draft copy look the way the computer already saw it. And the system became a little less effective.

4.5.5 *Results of the Program*

How do you overcome these problems? Well, we tried the usual and obvious methods. We established new procedures and tried to enforce them. We ran a series of seminars and lectures extolling the benefits of the new system. But the success of the system itself was the biggest impetus to getting people's cooperation.

In the beginning, of course, there were problems. The programs did not always work. We did not always feed data properly. And there was a "show me" attitude on the part of most of our staff.

The turning point came when we were due to deliver preliminary drafts of two sets of computer programming documentation -- one for the Mk 86 Mod 3 and one for the Mk 86 Mod 4. Each set comprised about 1,000 pages of program listings, and the sets were about one-third different. High-speed chain-printer output was to be used for the manuscript copy.

Several days before delivery, our subcontractor, Volt, was having computer problems. Volt was not able to print out in the format required. Panic was setting in. It would have been impossible to type a few thousand pages in a few days. So we waited. Finally, 3 days before delivery, Volt solved the difficulty and the Mod 3 programming documentation was printed out successfully. That night the correction codes to convert a Mod 3 document to a Mod 4 were fed into the computer. The next day, the Mod 4 programming documentation was printed out. Overnight, a 1,000-page document had been revised and produced. The system worked.

The real test, however, came early in 1972. On March 15 of that year, we delivered over 6,000 pages in negative form -- comprising over twenty-thousand 8-1/2 x 11 page units -- to the U.S. Navy for printing by the Government Printing Office. Delivery was on time and under budget.

The cutoff date for design freeze on the manuals had been January 15, 1972. In October of 1972, LEC had delivered the last of the Mk 86 Mod 1 versions of the manuals. We had spent November and December updating these books to the Mod 3 configuration, using a staff of about 40 technical writers, editors, operators, illustrators, and photographers. Then, on January 15, we had 60 days to incorporate last-minute changes and produce this huge volume of negatives by the March 15 deadline.

Figure 4-24 shows a normal technical publications production cycle. Using conventional techniques, there was almost no way we could have gotten where we had to go. We would have needed an army of proofreaders and operators and production people. Moreover, had we chosen either hot type or cold type, normal turnaround for support services would have been unacceptable. The costs of paying overtime premiums to meet our schedule would have been enormous.

Figure 4-25 shows the Mk 86 computerized production cycle. The steps are basically the same, although on some books, where changes were minimal, we entered the changes and the production codes at the same time. But although the steps are similar, the time sequences were dramatically shorter. For one thing, we proofread *only* the changes. Although entering the layout and composition codes took longer than simply specifying type fonts and sizes, the typesetting sequence was now measured in hours rather than days. And the product was camera-ready copy. All that had to be done was to add special symbols and rulings and paste the illustrations in place.

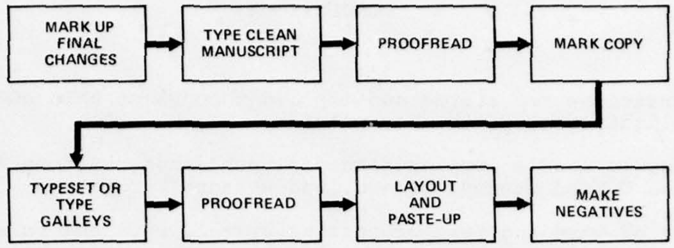


Figure 4-24. Typical Manual Publications Production Cycle

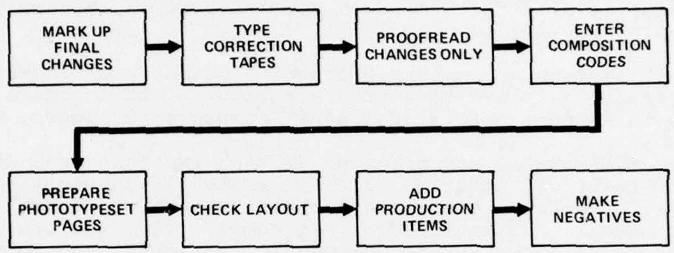


Figure 4-25. Automated Publications Production Cycle

Of course it was not that simple. Suppliers all over the New York area were kept busy making our negatives and blue-line reference copies. And simply keeping track of all the pieces, checking them out, and preparing for shipping represented a major logistics task. But on March 15, 1972, all 20,000 page units had been checked by LEC Quality Assurance and packaged, and were on the shipping platform.

That was several years ago. Since then we have delivered two more sets of Mk 86 books using the same techniques. Today, the nature of LEC's work is changing, and the available technology is changing, too. So we are looking at new media and techniques. One advantage that a smaller user has in leasing equipment and using subcontractors is that there is no irrevocable commitment to any approach. In fact, the use of leased equipment and subcontractor support gives the small user the potential for flexibility and growth that the large-volume user gets by using general-purpose digital computers and continually upgrading his software and peripherals.

5. CONCLUSIONS

Conclusions and observations are stated and implied throughout this AGARDograph. This section briefly highlights some of the key points.

1) The technology to handle complex technical publishing systems is available today throughout the United States, Canada, and Western Europe.

2) Manufacturers of word and text processing systems have not to any great degree faced up to the challenges of technical communications in the aerospace industry. Most systems and applications have been developed by the users themselves. Such specific needs as proportional spacing, complex mathematics, special symbols, multiple typefaces, and tables in a variety of formats, are available only in sophisticated systems. Moreover, lack of compatibility among systems and techniques has made it difficult to build special-purpose systems from readily available components.

3) Most available systems are either production oriented or end-item oriented; that is, their primary goals are to increase throughput or decrease handling time or provide outputs in some specified medium (camera-ready repro, microfiche, etc.).

4) Those systems that are author oriented -- that is, that seem designed to help the originator of technical material plan and write his document -- seem to emerge largely from the research environment rather than from design, development, production, and operational activities. In short, organizations like Lawrence Livermore Laboratories or Stanford Research Institute tend to ask: What does the scientist need or want? Organizations like Lockheed, Boeing, United Airlines, and the Naval Air Rework Facility at Jacksonville ask: How much can we store? How fast can we make changes? How quickly can we produce final material?

5) The requirements of the military may push text processing technology even further. These needs tend to be *user* oriented rather then either *author* oriented or *production* oriented. Their questions tend to be of the operational type: What does the maintenance man need to know? Under what conditions does he use the information? What effect does it have on safety? Reliability? Mission success?

6) Some of the advantages claimed by the word processing community, such as the ability to centralize the word and text processing functions for greater productivity, are resisted by the scientific community, where the complexity of the material makes dictation unlikely, and where the author wants direct control over his product. (Recent trends, however, indicate that resistance to centralization is also coming from a variety of other sources.)

7) New advances in microprocessing, vdu's, storage media, printing techniques, and ocr suggest that even the relatively small scientific or engineering office will soon be able to create accurate, sophisticated documents, and that the technical author will have at his disposal a tool to help him rather than a production medium he must put up with to save clerical and production time.

8) The technology versus cost trades that a potential user can make today permit a wide variety of choices. It is hard to imagine an aerospace technical documentation task so small that there is not some word processing system simple and inexpensive enough to help it. On the other extreme, there are few tasks so vast or complex that current technology cannot step up to it.

9) Because of the rapid growth of technology, any system a user adopts should accommodate change.

10) Because of the normal resistance to change, any new technology introduced should, where possible, be an extension of techniques the user is already familiar with.

11) Two unfortunate tendencies have been observed in the course of this study:

- At one extreme, there has been a reticence, either because of lack of knowledge or resistance to change, on the part of technical authors to adapt to new text processing technology.
- At the other extreme, there has been a trend, particularly in larger organizations, to institute more technology than is really required, to do things simply because they can be done, and then to force both technical authors and information users to modify their requirements in keeping with the limitations of the production system.

6. REFERENCES

1. Carrier, John P., Harry Diamond Laboratories, "Scientific and Technical Word Processing at Harry Diamond Laboratories," presented at NATO AGARD Technical Information Panel Workshop, Paris, 21 July 1976.

2. Gardels, Keith, "The Pros and Cons of Centralized Word Processing," *Proc. of the 23rd International Technical Communication Conference,* Washington, D.C., May 1976.

3. Wharton, Keith, "The Redifon Project," presented at NATO AGARD Technical Information Panel Workshop, Paris, 21 July 1976.

4. Edward G. Mitchell, Honeywell Information Systems, Waltham, Massachusetts, presentation at Computer-Assisted Editing and Composition Seminar, sponsored by Boston Chapter of the Society for Technical Communication, 26 September 1975.

5. "Computer Manufacturer Practices What It Preaches: Cost Reduction Through Automated Information Handling," *In-Plant Printer,* May 1976.

6. Stoddard, E.L., Raytheon Service Company, Andover, Massachusetts, "A Presentation on an Approach to Analyzing the 'Cost' of a Computer Assisted Editing and Composition System," presented at the Computer Assisted Editing and Composition Seminar, Boston Chapter of the Society for Technical Communication, Boston, Massachusetts, 26 September 1975.

7. Lockheed Missiles and Space Co., Inc., Sunnyvale, California, *Introduction to Autotext Publication System,* March 1976.

8. Moss, W.G., "Boeing Automated Publications," presented at Aerospace Industries Association and Air Transport Association Joint Symposium on Automated Publications, Scottsdale, Arizona, 20 May 1976.

9. Parker, John M. and Shortz, Guy, Jr., United Airlines, "Automation of the Small-Scale Technical Publishing System," presented at Aerospace Industries Association and Air Transport Association Joint Symposium on Automated Publications, Scottsdale, Arizona, 20 May 1976.

10. Perkins, D.D., Lockheed-Georgia Company, "Trip Report - Demonstration of TRUMP System at Jacksonville Naval Air Rework Facility," Jacksonville, Florida, 25 September 1975.

11. Boli, Beverly R., Michael, Elizabeth K., Rom, Raphael, van Nouhuys, Dirk H., and Weinberg, Ann C.. "Document Production and Control Systems," Augmentation Research Center, Stanford Research Institute, Menlo Park, California 94025, ARC Journal Number 37730, 1 March 1977.

7. BIBLIOGRAPHY

1. The Adjutant General Center, Department of the Army, *A Management Introduction to Word Processing*, DA DAM 340-2, U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 008-020-00548-7, 1 April 1975.

2. Berman, Paul I., "Automated Editing and The Technical Author; Where We Stand Today," *Proc. of the 23rd International Technical Communications Conference*, Society for Technical Communication, Washington, D.C., May 1976.

3. Berman, Paul I., "Computer-Assisted Publishing: A Case History," *Proc. of the 21st International Technical Communications Conference*, Society for Technical Communication, Washington, D.C., May 1974.

4. Boli, Beverly R., Michael, Elizabeth K., Rom, Raphael, van Nouhuys, Dirk H., and Weinberg, Ann C., "Document Production and Control Systems," Augmentation Research Center, Stanford Research Institute, Menlo Park, California 94025, ARC Journal Number 37730, 1 March 1977.

5. Bush, D.A. and Weaver, J.A., *OCR and its Application to Documentation*, NATO AGARD Technical Information Panel, AGARD-AG-216, March 1976.

6. Capital Systems Engineering Group, Inc., *Improving the Dissemination of Scientific and Technical Information* (prepared for The Office of Science Information Service, National Science Foundation), Rockville, Maryland, June 1976.

7. Gibbs, D.C.C., *Glossary of Documentation Terms; Part II: Computer-User Terms*, NATO AGARD Technical Information Panel, AGARD-AG-182-Pt II, September 1974.

8. Greenblatt, Robert, "Integrating Data Processing with Word Processing," presented at Syntopican IV, New York, New York, 22-24 June 1976.

9. Herr, David, *The Application of Computer Text Processing*, Bowne Time Sharing, Inc., 345 Hudson Street, New York, New York 10014, January 1976.

10. Hurley, Jack and Thomas, Jeff, "Automated Editing Systems Criteria-How Can Technical Authors' Needs Be Met?" Wordwright, Ltd., 12 Vandy Street, London E.C. 2, presented at NATO AGARD Workshop, Paris, 21 July 1976.

11. Meyer, N. Dean, *Executive Information Tools*, Augmentation Research Center, Stanford Research Institute, Menlo Park, California 94025, 18 December 1975.

12. Society for Technical Communication, *Glossary of Automated Text Processing Terms*, STC-47-74, Washington, D.C., 1974.

13. Sulit, Robert A., et al., *Navy Technical Manual System (NTMS) Program Development Plan*, AD/A-003468, Naval Ship Research and Development Center, Bethesda, Maryland, November 1974.

In addition to the above, there are several periodicals and special information services that are useful to those investigating text processing systems or engaged in technical communications.

1. *Datapro Information Services*. - Published by Datapro Research Corp., Delran, New Jersey. Presents information services on an annual basis.

2. *The Seybold Report*. - Published semimonthly by Seybold Publications, Inc., Haddonfield, New Jersey.

3. *Technical Communication*. - Published quarterly by Society for Technical Communication, Washington, D.C.

4. *Word Processing Report*. - Published semimonthly by Geyer-McAllister Publications, Inc., New York.

5. *Word Processing Report- International Edition*. - Published by Geyer-McAllister International, Inc., European publication office: Kew, Surrey, England.

6. *Word Processing World*. - Published bimonthly by Geyer-McAllister Publications, Inc., New York.

8. ACKNOWLEDGEMENTS

In preparing this survey, I contacted many American, Canadian, and European text processing manufacturers and service bureaus, most of whom where kind enough to send literature and permission to quote from it and, in many cases, to send representatives to speak with me. Obviously I could not use all the material provided to me in a study of this scope, nor could I confer with all of those who offered assistance. Actual trips made and persons contacted are listed in the appendixes. However, I must also acknowledge the help I got from all sectors of both the word processing and aerospace industries, and the generous interest shown in this program.

Specifically, I would like to thank those who attended the NATO workshop in Paris (see Appendix A), and who gave up their time for a few days to exchange ideas with me and broaden my outlook on what was being done in computerized publishing in the NATO community, and what the problems were.

I must also thank for their assistance Fred Dyer of Rome Air Development Center, who was my NATO AGARD point of contact during this study; Commander Alastair Whitehead and his staff at NATO AGARD, who arranged the Paris workshop; James Mathieu of Lockheed Missiles and Space Company, who provided considerable data and reviewed this report in draft form; Duane Stone of Rome Air Development Center, who also reviewed it in draft form; and Howard Maxwell of Lockheed-Georgia Company, whose diligence in keeping abreast of new publications technology and disseminating the information to his counterparts throughout Lockheed Aircraft Corporation provided much of the information used in this report.

Finally, I must thank Lockheed Electronics Company (LEC) for permission to undertake this study, and the Technical Publications Department of LEC's Products and Systems Division for illustrating, editing, and typing this report. Within LEC, I am particularly grateful to Ann Wasser, who did much of the data gathering and assembling for this report, as well as editing it and supervising its production.

Appendix A.

LIST OF ATTENDEES AT AGARD TIP WORKSHOP

On 21 and 22 July 1976, AGARD TIP sponsored a *Workshop on Computer-Assisted Writing and Editing Systems* at the United States Trade Center in Neuilly sur Seine, France. This conference was a first attempt for international users of the NATO community to discuss word processing applications within the framework of a single industry and, as such, represented a key element in this study. Participants in the workshop are listed below:

FRANCE

Mr A HOROVEANU
Manager, Technical Publications
Honeywell Bull
94 Avenue Gambetta
75960 Paris Cedex 20

Mme MARQUET
Directeur Scientifique du Service d'Etude et de Caractérisation des Emulsions Photosensibles (SECEP)
Institut d'Optique
3 Bd Pasteur, 75015 Paris

Mlle Astrid MERLO
Marketing Manager
Olivetti France S.A.
91 rue du Fbg Saint-Honoré
Paris 8e

Mr SAGAUT
Service d'Etude et de Caractérisation des Emulsions Photosensibles (SECEP)
Institut d'Optique
3 Bd Pasteur, 75015 Paris

Mr Max SALMON
Chef du Service des Relations Extérieures et de la Documentation
ONERA
29, Avenue de la Division Leclerc
92320 Châtillon-sous-Bagneux

GERMANY

Mr Rüdiger BERNHARDT
Leiter der Programmierabteilung
Zentralstelle für Maschinelle Dokumentation (ZMD)
6 Frankfurt/Main Niederrad
Herriotstrasse 5

Dr H J EHLERS
Chairman Fachnormenausschuss Bibliotheks- und Dokumentationswesen
c/o Ernst Klett
Ref UA
P O Box 809
D 7000 Stuttgart 1

NETHERLANDS

Mr J J HAANSTRA
Fokker-VFW
Technologisch Centrum
Schiphol Oost

Drs P J W ten HAGEN
Stichting Mathematisch Centrum
2e Boerhaavestraat 19
Amsterdam

Mr A A ROMMERTS
Deputy Manager
Technical Publications Dept
Fokker-VFW
Schiphol Oost

Ir A WOUTERSEN
IBM
Boerhaavelaan 11
Zoetermeer

U S

Mr P I BERMAN
Manager, Technical Services
Lockheed Electronics Company, Inc
Products & Systems Division
US Highway 22
Plainfield, New Jersey 07061

Mr John P CARRIER
Chief, Scientific & Technical Info Office (DRXDO-TI)
US Dept of Army
Harry Diamond Labs
2800 Powder Mill Road
Adelphi, Md 20783

U K

Mr J H CLIFFORD
Manager, Management Services
Redifon Flight Simulation Ltd
Gatwick Road
Crawley, Sussex

Mr John COOPER
Computaprint Ltd
40 Bowling Green Lane
London EC1R ONE

Mr W A CROSSLEY
Computer Manager
Mullard Research Labs
Cross Oak Lane
Salfords
Redhill, Surrey RH1 5HA

Mr Chris ELLIS
IBM Nederland NV
Weesperplein 4
Amsterdam

Mr Bruce B GORDON
Technical Director
Leterite Co Ltd
35-37 Holgate Drive
Luton, Beds LU4 OXA

Mr F C HOLLAND
Technical Manager
The Monotype Corporation Ltd
Salfords, Redhill
Surrey RH1 5JP

Mr Colin HOLROYD
Computaprint Ltd
40 Bowling Green Lane
London EC1R ONE

Mr Jack HURLEY
Wordwright Ltd
12 Vandy Street
London EC2A 2EN

Mr K I McKENZIE
Director
TRIAD Computing Systems Ltd
1 Dorset Buildings
Salisbury Square
London EC4Y 8ES

Mr Alan PATERSON
Logica Limited
P O Box 4SE
64 Newman Street
London W1A 4SE

Mr John SCOTT
Computaprint Ltd
40 Bowling Green Lane
London EC1R ONE

Mr S C SCHULER
Head, Defence Research
Information Centre (DRIC)
Station Square House
St Mary Cray
Orpington, Kent BR5 3RE

Mr Peter F SMITH
Atlas Computing Division
Rutherford Laboratory
Chilton, Didcot, Oxon OX11 OQX

Mr Jeff THOMAS
Wordwright Limited
12 Vandy Street
London EC2A 2EN

Mr J A WEAVER
Mullard Research Labs
Cross Oak Lane
Salfords, Redhill, Surrey RH1 5HA

Mr Keith WHARTON
Keith Wharton Consultants
10 Hamilton House
High Park Road
Kew, Surrey TW9 4BJ

Mr A M WOODWARD
ASLIB Research & Development
Department
36 Bedford Row
London WC1R 4JH

AGARD

Mr A J R WHITEHEAD, Executive, Technical Information Panel

Mr J H TROTMAN, Scientific Publications Executive

Miss G SHUTTLEWORTH, Secretary, Technical Information Panel

APPENDIX B.

LIST OF PERSONS CONTACTED

During the course of this study, many interested people called and wrote to offer help, and many took time out to either visit or telephone me or invite me or my associates to their facilities. Within the limited score of the study, it was impossible to visit with all those who, in addition to those listed in Appendix A, we actually were able to confer with. If any names are inadvertently omitted, we apologize for the oversight.

Stephen J. A'Hearn
Information International, Inc.
5933 Slauson Avenue
Culver City, California 90230

Ray Atkins
Systems Consultants, Inc.
936 West Main Street
Middletown, Rhode Island 02840

Robert E. Barnes
Vydec, Inc.
55 Madison Avenue
Morristown, New Jersey 07960

James F. Barrick, Jr.
Xerox Corp.
284 Sheffield Street
Mountainside, New Jersey 07092

Charles K. Bauer
Lockheed-Georgia Company
Technical Information Department
Dept. 72-34 Zone 7
Marietta, Georgia 30060

Aldo T. Benenati
Avionic Products Engineering Corp.
Ford Road
Denville, New Jersey 07834

William F. Campbell, Code 5640
Ships Publications Division
Naval Ship Weapon Systems Engineering Station
Port Hueneme, California 93043

Bruce Cooperman, Consultant
14 Elliot Hill Road
Natick, Massachusetts

Gerald DiPippo
Volt Information Sciences, Inc.
6901 Jericho Turnpike
Syosset, New York 11791

Robert Donetti
Wang Laboratories
836 North Street
Tewksbury, Massachusetts 01876

Fred S. Dyer
Rome Air Development Center
Mail Code TI
Griffiss Air Force Base, New York 13440

Walter J. Fay
Redactron Corp.
1200 Route 46
Clifton, New Jersey 07013

Robert Greenblatt
Business Systems Consultant
P.O. Box 182
New City, New York 10956

Susan Gunsher
Compugraphic
2 Pennsylvania Plaza
Suite 1888
New York, New York 10001

Merrily Haken
Redactron Corp.
1200 Route 46
Clifton, New Jersey 07013

Paula Hantman
U.S. Army Word Processing Branch
Forrestal Building
12th and Independence Avenue
Washington, D.C. 20314

Richard W. Harris
Omnitext
One Newton Executive Park
Lower Newton Falls, Massachusetts 02162

Dr. James Kasprzak
HQDA (DAAG-AMS-W)
U.S. Army Word Processing Branch
Forrestal Building
12th and Independence Avenue
Washington, D.C. 20314

Eugene Kelly
Raytheon Service Center
Andover, Massachusetts 01810

John Kempton
Publications Section
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91103

William E. Kendrick, Jr.
Vydec, Inc.
55 Madison Avenue
Morristown, New Jersey 07960

Captain Fred Kliett
U.S. Army Word Processing Branch
Forrestal Building
12th and Independence Avenue
Washington, D.C. 20314

Robert Lieberman
Augmentation Research Center
Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

Larry Little
Technical Information Department
Lawrence Livermore Laboratories
Livermore, California

Richard T. Ludwig
Ships Publications Division
Naval Ship Weapon Systems Engineering Station
Port Hueneme, California 93043

James Mathieu
Lockheed Missiles and Space Co., Inc.
Orgn. 19-32, Bldg. 102
1111 Lockheed Way
Sunnyvale, California 94088

Craig Maxwell
Comarco, Inc.
227 West Hueneme Road
Oxnard, California 93030

Howard Maxwell
Dept. 72-40 Zone 73
Lockheed-Georgia Company
Marietta, Georgia 30060

Richard L. McIntyre
General Electric Company
Court Street
Syracuse, New York 13201

Edward J. Meleniak
Avionic Products Engineering Corp.
Ford Road
Denville, New Jersey 07834

Edward G. Mitchell
Honeywell Information Services
Waltham, Massachusetts

Richard L. Omerso
Capital Systems Group, Inc.
6110 Executive Boulevard, Suite 850
Rockville, Maryland 20852

Lynda Page
Wang Laboratories
836 North Street
Tewksbury, Massachusetts 01876

Rosallie Papoutsy
Wang Laboratories
836 North Street
Tewksbury, Massachusetts 01876

Anthony Paratore
Wang Laboratories
Plaza 22 Building
U.S. Highway 22 at Summit Road
Mountainside, New Jersey 07092

Michael G. Perkons
Vydec, Inc.
55 Madison Avenue
Morristown, New Jersey 07960

David A. Potter
Stanford Research Institute
Office-1
163 Hamilton Avenue
Princeton, New Jersey 08540

Kenneth Powers
Vydec, Inc.
55 Madison Avenue
Morristown, New Jersey 07960

Elsa Pressentin
Technical Information Department
Lawrence Livermore Laboratories
Livermore, California

Nelson M. Rong
Compugraphic
2 Pennsylvania Plaza
Room 1888
New York, New York 10001

Lorraine Rosenfeld
Wang Laboratories
Plaza 22 Building
U.S. Highway 22 at Summit Road
Mountainside, New Jersey 07092

Stephanie Rosenbaum
Tec-Ed
Technical Publications and Graphic Services
P.O. Box 1905
Ann Arbor, Michigan 48106

Arthur Sanders
Lockheed Missiles and Space Co., Inc.
Orgn. 19-32, Bldg. 102
1111 Lockheed Way
Sunnyvale, California 94088

E. L. Stoddard
Raytheon Service Center
Andover, Massachusetts 01810

Duane L. Stone
Rome Air Development Center (ISCP)
Griffiss Air Force Base, New York 13440

Frank D. Toohey
Mergenthaler Linotype Company
Mergenthaler Drive
P.O. Box 82
Plainview, New York 11803

Jack Triska
Information Management Department
3M Business Products Sales, Inc.
70 Eisenhower Drive
Paramus, New Jersey 07652

George Tsetsilas
Wang Laboratories
836 North Street
Tewksbury, Massachusetts 01876

Robert M. Van Buren
Publications Section
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91103

Dirk H. van Nouhuys
Augmentation Research Center
Stanford Research Institute
333 Ravenswood Avenue
Menlo Park, California 94025

APPENDIX C.

LIST OF VISITS AND CONFERENCES

Society for Technical Communication, Boston Chapter, Seminar on Computer-Assisted Editing and Composition. Boston, Massachusetts, 26 September 1975.

Mergenthaler Linotype Co. Plainview, New York, 18 March 1976.

U.S. Army Adjutant-General Corps. Washington, D.C., 12 May 1976.

The 23rd International Technical Communication Conference, sponsored by the Society for Technical Communications. Washington, D.C., 12-15 May 1976.

*Aerospace Industries Association and Air Transport Association, Joint Symposium on Automated Technical Publications. Scottsdale, Arizona, 20 May 1976.

Syntopican IV, sponsored by the International Word Processing Association. New York, New York, 22-24 June 1976.

Wang Laboratories. Tewksbury, Massachusetts, 30 June 1976.

Raytheon Service Center. Andover, Massachusetts, 30 June 1976.

Volt Information Sciences, Inc. Syosset, New York, 19 July 1976.

AGARD Technical Information Panel Workshop on Computer-Assisted Writing and Editing Systems. Neuilly sur Seine, France, 21-22 July 1976.

Naval Ship Weapon Systems Engineering Station. Port Hueneme, California, 13 September 1976.

Jet Propulsion Laboratory. Pasadena, California, 14 September 1976.

Lockheed Missiles and Space Co. Sunnyvale, California, 15 September 1976.

Lawrence Livermore Laboratories. Livermore, California, 16 September 1976.

Augmentation Research Center, Stanford Research Institute. Menlo Park, California, 17 September 1976.

*Aerospace Industries Association Symposium on Automated Technical Publications. Seattle, Washington, 6-7 October 1976.

Rome Air Development Center. Griffiss Air Force Base, New York, 13 October 1976.

Vydec, Inc. Morristown, New Jersey, October 1976.

Avionic Products Engineering Corp. Denville, New Jersey, October 1976.

*Attended by Howard Maxwell, Lockheed-Georgia Company.

59

REPORT DOCUMENTATION PAGE

1. Recipient's Reference	2. Originator's Reference	3. Further Reference	4. Security Classification of Document
	AGARD-AG-229	ISBN 92-835-1251-0	UNCLASSIFIED

5. Originator

Advisory Group for Aerospace Research and Development
North Atlantic Treaty Organization
7 rue Ancelle, 92200 Neuilly sur Seine, France

6. Title

SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS

7. Presented at

8. Author(s)	9. Date
P.I.Berman	July 1977

10. Author's Address	11. Pages
Lockheed Electronics Company, Inc. US Highway 22, Plainfield, New Jersey 07061, USA.	66

12. Distribution Statement

This document is distributed in accordance with AGARD policies and regulations, which are outlined on the Outside Back Covers of all AGARD publications.

13. Keywords/Descriptors

Word processing	Automated publishing
Text processing	Technical author
Technical publications	Documentation systems

14. Abstract

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends of automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

This AGARDograph was prepared at the request of the Technical Information Panel of AGARD.

AGARDograph No. 229
Advisory Group for Aerospace Research and Development, NATO
SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS
P.I.Berman
Published July 1977
66 pages

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends of

P.T.O.

AGARD-AG-229

Word processing
Text processing
Technical publications
Automated publishing
Technical author
Documentation systems

AGARDograph No. 229
Advisory Group for Aerospace Research and Development, NATO
SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS
P.I.Berman
Published July 1977
66 pages

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends of

P.T.O.

AGARD-AG-229

Word processing
Text processing
Technical publications
Automated publishing
Technical author
Documentation systems

AGARDograph No. 229
Advisory Group for Aerospace Research and Development, NATO
SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS
P.I.Berman
Published July 1977
66 pages

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends of

P.T.O.

AGARD-AG-229

Word processing
Text processing
Technical publications
Automated publishing
Technical author
Documentation systems

AGARDograph No. 229
Advisory Group for Aerospace Research and Development, NATO
SURVEY OF COMPUTER-ASSISTED WRITING AND EDITING SYSTEMS
P.I.Berman
Published July 1977
66 pages

This AGARDograph is directed toward the technical author in the aerospace industry. It surveys the available technology for automating the preparation of technical and scientific documents, and it attempts to demonstrate the range of possibilities inherent in such technology by reviewing a number of typical system configurations. It also tries to suggest the trends of

P.T.O.

AGARD-AG-229

Word processing
Text processing
Technical publications
Automated publishing
Technical author
Documentation systems

automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

This ACARDograph was prepared at the request of the Technical Information Panel of AGARD.

ISBN 92-835-1251-0

automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

This AGARDograph was prepared at the request of the Technical Information Panel of AGARD.

ISBN 92-835-1251-0

automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

This AGARDograph was prepared at the request of the Technical Information Panel of AGARD.

ISBN 92-835-1251-0

automated publishing systems and to provide some qualitative guidelines for selecting and implementing such systems.

This AGARDograph was prepared at the request of the Technical Information Panel of AGARD.

ISBN 92-835-1251-0